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ESTABLISHING GUIDELINES FOR THE SEPARATION OF SOLID WASTE DISPOSAL SITES AND AIRPORTS IN THE NORTHWEST TERRITORIES. FINAL REPORT - PHASE 1. / Soberman, R.M.; Heinke, G.W.; Lovicsek, M. 1990.

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Final Report - Phase I

prepared for

**Community Works and Capital Planning
Department of Municipal and Community Affairs
Government of the Northwest Territories**

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- o Alistair Pinoss, Technical Assistant, International Civil Aviation Organization
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1. Background of the Study - Phase I

A study was initiated in January 1988 by the Department of Municipal and Community Affairs (MaCA), Government of the Northwest Territories, to evaluate the existing guidelines of Transport Canada for the separation of solid waste disposal sites and airports. The Government of the NWT was concerned that a strict application of the existing 8 km separation guideline would have profound cost implications. Dr. R. M. Soberman, P.Eng., and Dr. G. W. Heinke, P.Eng., were engaged, through Transmode Consultants Inc., to evaluate the appropriateness of the Transport Canada guidelines for the situation encountered in the NWT. It was desirable to have an interim report completed by June 1988 for the purpose of proceeding with the possible construction of new solid waste disposal facilities in the Kitikmeot region.

The interim report was submitted in June 1988. It recommended that the Government of the NWT develop guidelines for the separation between solid waste disposal sites and airports that are relevant to conditions encountered in the various regions of the territories. To facilitate the development of such guidelines, the report also recommended the improvement of the data base on incidents involving bird strikes on aircraft at NWT airports, and the carrying out of special surveys to supplement the limited data presently available on bird-population characteristics peculiar to different regions of the NWT. Because it will take several years to obtain this data, the guidelines to be developed would be only interim, subject to revision, when the longer-term data collection has produced results.

The interim report also evaluated five specific communities in the Kitikmeot region (Coppermine, Gjoa Haven, Holman, Pelly Bay and Spence Bay), in which work on the solid waste disposal situation was to be carried out in 1988.

Subsequent to the submission of the June 1988 interim report, informal discussions took place between Transport Canada and Government of NWT

officials. Transport Canada agreed that the 8 km separation distance may not be appropriate for general application to NWT airports. Specific approvals were given on a few communities where improvements to existing solid waste facilities or newly constructed facilities were undertaken in 1988 and 1989.

Discussions also occurred between MaCA and two departments of the NWT government, Transportation and Renewable Resources, regarding their input for the preparation of interim guidelines. Specific responses by Mr. Gordon Barber, Assistant Deputy Minister, NWT Transportation, and by Mr. P. Kraft, Acting Director, Wildlife Management, NWT Renewable Resources, have been incorporated into this report.

The consultants were recently asked to update the interim report of June 1988 by April 1990. This report is the response. It must be emphasized that little progress has been made in the intervening year and a half towards attempting to propose "Guidelines for the Siting of Solid Waste Disposal Sites in the Vicinity of Community Airports in the Northwest Territories". However, it is hoped that the completion of this study will provide the momentum to carry out the following three actions:

1. Documentation by NWT Transportation of the occurrence of bird aircraft strikes at NWT airports in the past. This effort would provide data on the magnitude of the problem at various airports, and on the lack of real problems at others. This effort would also provide guidance as to which locations to carry out bird population characteristics studies.
2. Implementation of bird population characteristics studies by NWT Renewable Resources, or its consultants, in selected locations as indicated in 1. above.
3. Discussions, initiated by MaCA with Transport Canada, on the process which will lead to the development of guidelines specific to the regions of the Northwest Territories, recognizing that in the absence of essential data, interim guidelines will have to be agreed upon.

2. Introduction

Hazards associated with bird strikes on aircraft have increasingly attracted worldwide attention by those responsible for aviation safety as well as by the general public. Over the past three decades, the reported frequency of bird-aircraft collisions has risen considerably, partly as a result of improved reporting systems and partly as a result of technological change, notably a much-increased preponderance of higher speed, jet and turbo propelled aircraft. At higher speeds, both the probability of a collision and extent of damage increase, and with jet engines, ingestion of birds can lead to loss of power or engine failure and possibly disastrous results. With the anticipated increase in the number of high-speed aircraft, aviation safety related to bird-aircraft collisions is expected to be even further jeopardized in the future.

Bird hazards to aviation safety are predominantly airport-related problems occurring at relatively low altitudes associated with takeoffs and landings. Authorities responsible for aviation safety, therefore, are basically concerned with measures for reducing the attractiveness of airport sites and their surroundings to bird populations, in order to minimize the likelihood of bird-aircraft collisions on airport approaches. As a result, as one countermeasure, various agencies such as the International Civil Aviation Organization (ICAO), Transport Canada, and the U.S. Federal Aviation Authority (FAA) have proposed zoning regulations and guidelines for the control of land use in the general vicinity of airports. Some of these guidelines deal specifically with the location of solid waste disposal sites, because of the attractiveness of such facilities as a major source of food for birds. Current Transport Canada guidelines, for example, recommend a minimum separation of 8 km between an airport and any solid waste disposal site.

The attractiveness of airport sites for birds depends upon a number of factors including local topography and vegetation surrounding the airport, the location of the airport in relation to migratory paths and bird flyways, and the proximity of bird feeding and nesting sites to the airport itself.

As a result, guidelines applicable for airports in large urban areas, where the environment of the airport itself is relatively attractive to birds in relation to the surrounding built-up areas, may not be appropriate for airports in remote regions, where there is little difference between the environment of the airport and the surrounding land use and terrain.

This study deals specifically with minimizing bird hazards at airports in the Northwest Territories, with special emphasis on hazards associated with solid waste disposal sites near airports. The objective is to provide information and analysis that will assist in establishing guidelines for the separation distance between solid waste disposal sites and airports in the Northwest Territories which reflect climatic and topographical conditions, bird population characteristics, the nature of aviation activity, and other factors peculiar to the region. A brief investigation by Cameron(1) showed that only four communities meet the minimum recommended guideline of Transport Canada of 8 km between the solid waste disposal site and the airstrip. The mean shortest distance between the solid waste disposal site and the airstrip for all other communities for which data was available is approximately 2 km.

The report begins with a general discussion of the bird-hazard problem in terms of the consequences of bird strikes, bird-strike statistics and the vulnerability of airports to bird hazards. Legislation, guidelines and regulations respecting the location of waste disposal sites relative to airports in Canada are then summarized and compared to those adopted internationally and in the United States. Some of the key factors that generally influence bird activity near airports are treated next. Control measures which can be taken to counteract the natural attraction of birds to airport vicinities are then considered, with a view to establishing appropriate guidelines for new waste disposal sites to be located in the vicinity of an airport in the Northwest Territories. Planning implications for the siting of solid waste disposal sites near airports- are then discussed. Finally, conclusions and recommendations are made on the steps necessary to be taken for the development of "Guidelines for the Siting of Solid Waste Disposal Sites in the Vicinity of Community Airports in the Northwest Territories".

The interim June 1988 report included a detailed examination of the existing situation with respect to solid-waste disposal and airport safety in five communities: Coppermine, Gjoa Haven, Holman, Pelly Bay and Spence Bay. This examination has been summarized in Appendix A. No attempt has been made to update information from the conditions existing in the spring of 1988.

3. Nature of the Bird Hazard

Bird strikes can damage aircraft to varying degrees, including both external damage (shattered windshields obstructing the flight crew's vision, destroyed landing lights, structural damages to airframes) and internal damage (blockage of air flow to engines, coolers, superchargers, etc.). The most serious collisions involve ingestion of birds into the engine (especially of a jet or turbo-jet), possibly resulting in temporary loss of power, damage to fan blades, total destruction of the engine, or even causing the aircraft to crash.

Forced landings due to bird strikes are fairly common. One example involved the ingestion of between twenty and thirty herring gulls into both engines of a B737 aircraft taking off from Edmonton International Airport in June, 1984. Despite an engine being completely disabled, the plane managed a safe landing. The major damages included broken turbine blades and a destroyed vortex dissipator. Other bird-stricken aircraft have not fared as well as Edmonton's B737. Aside from safety, the costs of repairing and replacing damaged aircraft, the costs of downtime for inspection and repair, and the costs and inconvenience of rescheduling passengers and air cargo as a result of bird strikes cannot be ignored.

Exhibit 1 provides details on selected worldwide bird-strike incidents with civil aircraft which resulted in a serious injury and/or loss of life. The fifteen Canadian airports which reported the greatest number of bird-strike incidents during the four-year period between 1983 and 1986 are listed in Exhibit 2. In 1986, 868 bird-strike incidents at Canadian airports were

Exhibit 1

Worldwide Bird Strike Incidents Involving Serious Injury or Loss of Life

Date	Aircraft	Location	Part(s) Struck	Bird(s)	Effects
04-10-60	Lockheed Electra	Boston, U.S.	Engine	Starlings (Sturnus Vulgaris)	62 deaths, 9 serious injuries
23-11-62	Vickers Viscount	Maryland, U.S.	Tailplane	Whistling Swan (Cygnus Columbianus)	17 deaths
26-02-73	Lear 24	Atlanta, U.S.	Engine	Cowbirds (Molothrus Ater)	7 deaths, one third party serious injury
12-11-76	Falcon 20	Naples, Florida, U.S.	Engine	Ring-billed Gull (Larus Delawarensis)	11 serious injuries
07-04-81	Gates Lear 23	Lunken, U.S.	Windshield	Loon (Gaviidae)	Fatal injuries
08-08-81	Cessna 402	Mara Bridge, Kenya	Windshield	Ruppell's Griffon (Gyps Rueppellii)	Fatal injuries
08-09-81	Military	Durke Lakefront, U.S.	Unknown	2-10 Gulls (Larus Species)	Aircraft crashed, pilot was killed
07-11-88	Bell 206	New York, U.S.	Windshield	Gull (Larus Species)	Precautionary landing, serious injuries

Source: J. Thorpe, Analysis of Bird Strikes Reported by European Airlines 1972 to 1976
International Civil Aviation Organization, Aerodromes, Air Routes and Ground Aids Section

Exhibit 2
Bird Strikes at Canadian Airports
1983-1986

Airport	1983	1984	1985	1986	Total	Average
Vancouver International	114	67	47	65	293	73.3
Toronto International	68	32	52	57	209	52.3
Halifax International	14	19	74	56	163	40.8
Dorval International	42	34	33	53	162	40.5
Winnipeg International	24	22	9	41	96	24.0
Ottawa International	22	23	21	15	81	20.3
Calgary International	22	11	15	17	65	16.3
St. John's (Nfld.)	16	8	18	21	63	15.8
Mirabel International	15	15	11	21	62	15.5
Edmonton International	17	16	10	11	54	13.5
Thunder Bay	11	7	22	13	53	13.3
Quebec	4	16	11	14	45	11.3
Yellowknife	17	2	14	9	42	10.5
Windsor	7	10	14	9	40	10.0
Kelowna	1	15	11	11	38	9.5

Source: International Civil Aviation Organization, Aerodromes, Air Routes and Ground Aids Section

reported to the Airports Authority Group of Transport Canada. In general, about 15% of these resulted in precautionary landings. Vancouver International Airport heads the list with an average of 73.3 bird strikes per year, equivalent to a strike about every five days.

Bird-strike incidents in the Northwest Territories reported during the 1983-1986 time period are presented in Exhibit 3. Counts at most of the nine Northwest Territories airports shown are quite low - averaging less than three bird strikes per year except for Yellowknife and Hay River. All Northwest Territories airports cited are Transport Canada airports, and four out of the nine airports are located in the southern, relatively populous Fort Smith Region of the Territories.

The statistics of Exhibits 2 and 3 were compiled by the Canadian Aviation Safety Board (CASB) which superceded the Canadian Air Transportation Administration (CATA) in 1984. Following a bird-strike incident at a Transport Canada airport, reports from pilots, airport staff and airline headquarters are mailed to the Airport Authorities Group of Transport Canada. These reports are then forwarded to CASB where they are stored in computer files (all duplicates being eliminated in the filing process). The specific data listings produced by CASB rely on four different report sources, each offering a unique perspective on a given bird-strike incident:

i. Aircraft Operator Bird-Strike Report (Pilot Report)

- o provides accurate information on flight parameters at the time of collision
- o the report form (reproduced here as Exhibit 4) is similar in format and coded to be compatible with a report form used by the International Civil Aviation Organization (ICAO).

Exhibit 3

Bird Strikes at Northwest Territories Airports 1983-1986

Airport	1983	1984	1985	1986	Total	Average
Yellowknife	17	2	14	9	42	10.5
Hay River	8	10	10	5	33	8.3
Fort Smith	1	3	4	1	9	2.3
Norman Wells	1	1	5	0	7	1.8
Fort Simpson	3	0	2	0	5	1.3
Inuvik	1	0	2	0	3	0.8
Cambridge Bay	2	0	0	0	2	0.5
Hall Beach	0	0	0	1	1	0.3
Iqaluit	0	0	1	0	1	0.3

Source: International Civil Aviation Organization, Aerodromes, Air Routes
and Ground Aids Section

ii. Airport Staff Bird-Strike Report (Site Report)

- o completed by airport staff after the pilot or air traffic controller has reported a strike or, in the absence of such a report, if evidence of a strike is found on the airport property
- o provides information on the species of bird(s) involved

iii. Airline Headquarters Report

- o submitted by the head offices of Canada's major commercial airlines
- o provides information on the nature and extent of damages to aircraft, repair costs, and operational effects

iv. Department of National Defence (DND) Report

- o completed by pilots of military aircraft according to DND regulations
- o similar in format to the Pilot Report used in conjunction with civil aircraft
- o reviewed by the DND prior to being forwarded to CASB

The effect of bird-strike incidents at Northwest Territories airports or airstrips, which are operated by the Arctic Airports Division of NWT Transportation, is not documented. However, NWT Transportation indicated... "we have had no injuries as a result of strikes, but there -have been extremely expensive engine replacements and structural repairs reported. The problem has cost air carriers a great deal over the years (Barber, 1989)".

4. Current Guidelines and Regulations

Due to the seriousness of bird hazards at airports, the Government of Canada has instituted legislation dealing primarily with zoning regulations that address this problem. In Section 3.9 of the **Aeronautics Act**¹, the Governor in Council is awarded the power to make regulations respecting:

- o activities at aerodromes and the location, inspection, certification, registration, licensing and operation of aerodromes"(e);
- o "the use of airspace or aerodromes"(1); and
- o "the enforcement of such laws as may be deemed necessary for the safe and proper operation of aircraft"(n).

More specifically, the Governor in Council's authority to make zoning regulations is established in Section 4.4(2). These regulations serve the purpose of:

"preventing lands adjacent to or in the vicinity of an airport site from being used or developed in a manner that is, in the opinion of the Minister, incompatible with the safe operation of an airport or aircraft."

For example, zoning regulations implemented in June, 1987 with respect to Toronto/Buttonville Airport limit the height of new buildings, structures and objects and prohibit the disposal of any waste edible by or attractive to birds on lands adjacent to the airport. Such zoning regulations can be issued by the Governor in Council, however, only where the Minister has been unable to reach agreement with the relevant provincial government concerning compatible land use or development, or where immediate action is necessary to prevent incompatible land use. These zoning regulations are not retroactive.

¹ Transport Canada, **Air Regulations and Aeronautics Act (October, 1987).**

Other regulations accompanying the Aeronautics Act also deal with federal control over airports in Canada. According to Part III of the Regulations, airports must be licensed (300), licenses are to be issued by the Minister of Transport (301), the Minister may prescribe the conditions upon which airport licenses may be issued (303) and may cancel or suspend an airport license, at any time, for any reason that seems sufficient (304). (A 'license' is required if airports are to be used by scheduled carriers.) Licenses contain conditions relating to several factors including "the use and operation of the airport as the Minister deems necessary", and these licensing conditions are open to amendment, at any time, by the Minister. The aerodrome regulations, then, reinforce Federal control of airport operations. Control is exercised by allowing licenses to be withheld or rescinded in the event of an airport's failure to comply with any operating conditions the Minister might consider necessary, which could well include bird hazard prevention measures.

In its **Manual of Bird Hazard Control**², Transport Canada has formulated a set of standards and guidelines related to its policy to "institute effective programs and procedures to control and minimize bird-strike hazards to aircraft at Transport Canada airports". Issues covered in the manual include modifications to the airport environment, hazards associated with waste disposal sites, sewage lagoons, the disposal of sewage sludge, bird scaring, permits to scare or kill birds, and compliance with standard agricultural lease clauses.

The following four standards from the Transport Canada manual pertain specifically to the disposal of waste on or near airports:

- o No solid waste containing food garbage **shall** be dumped on airport property.
- o Garbage dumps containing food garbage **shall** not be located on land owned by Transport Canada.

² Transport Canada, **Manual of Airport Bird Hazard Control**, AK-75-10-000, Airports and Construction (1983).

- o Local municipal officials **shall** be made aware of the bird hazards to aircraft associated with garbage dumps on privately owned lands surrounding the airport.
- o Garbage dumps containing food garbage **should** not be located within an 8 km radius of an airport.

The 8 kilometre separation distance specified above is represented diagrammatically in the Transport Canada manual and reproduced here as Exhibit 5. Note that the recommended separation along each runway centreline extends beyond 8 km by an undefined distance (about 2 kilometres, if the diagram is drawn to scale).

Another Transport Canada publication, **Land Use in the Vicinity of Airports**³, also makes reference to the 8 kilometre separation guideline. The basic rationale for the 8 kilometre separation lies in the relationship between the flying altitude of gulls (the scavenger bird involved in most Canadian bird-aircraft collisions) and the minimum take-off/approach gradient (or glide path) of aircraft). If the former is taken to be about 150 metres and the latter about 2%, the separation distance needed to avoid collisions is calculated to be roughly 8 kilometres, as shown in Exhibit 6.

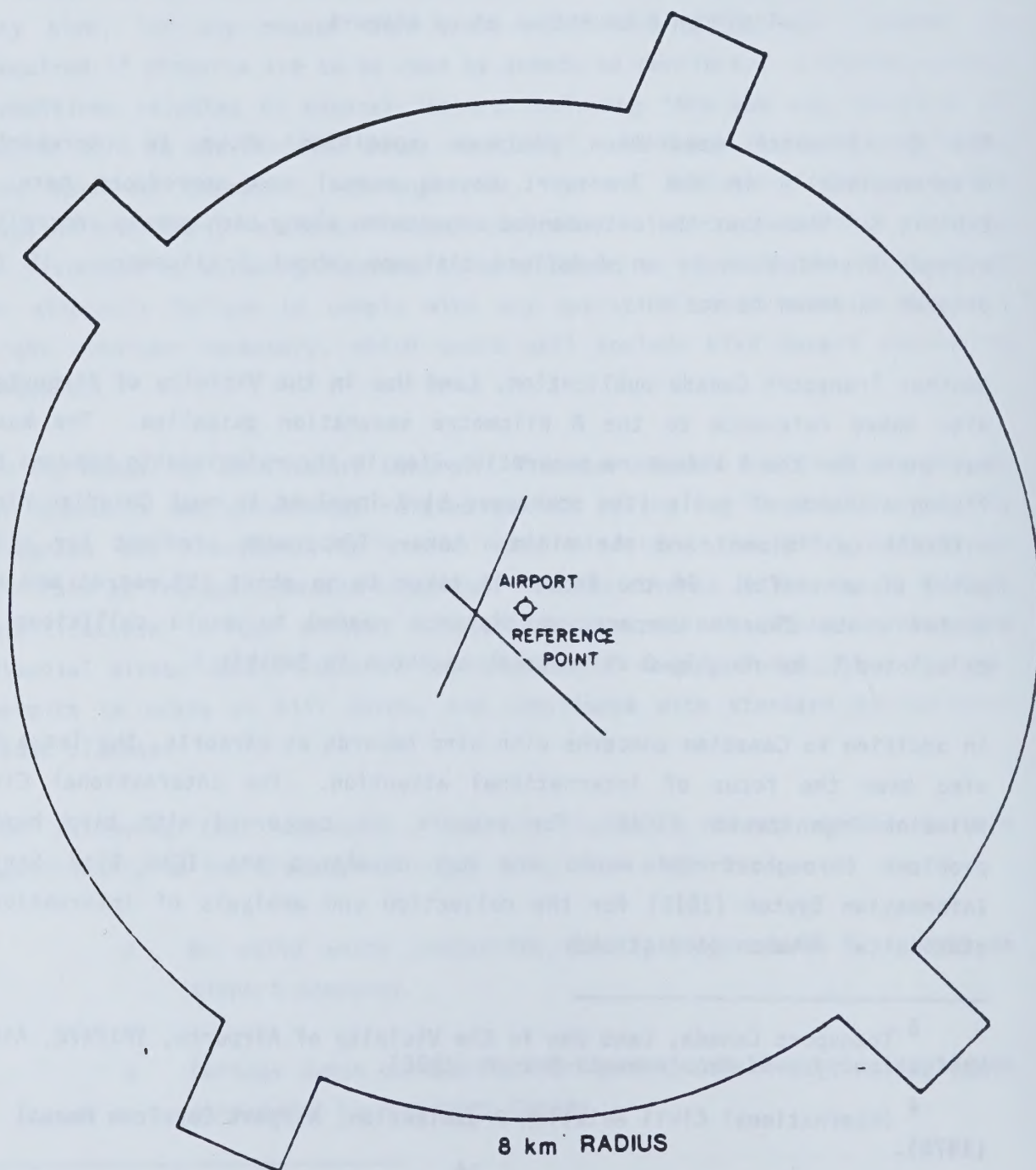
In addition to Canadian concerns with bird hazards at airports, the issue has also been the focus of international attention. The International Civil Aviation Organization (ICAO), for example, is concerned with bird hazard problems throughout the world and has developed the ICAO Bird Strike Information System (IBIS) for the collection and analysis of international statistical data on bird strikes.

³ Transport Canada, **Land Use in the Vicinity of Airports**, TP1247E, Air Navigation Systems Requirements Branch (1985).

⁴ International Civil Aviation Organization, **Airport Services Manual** (1978).

Exhibit 5

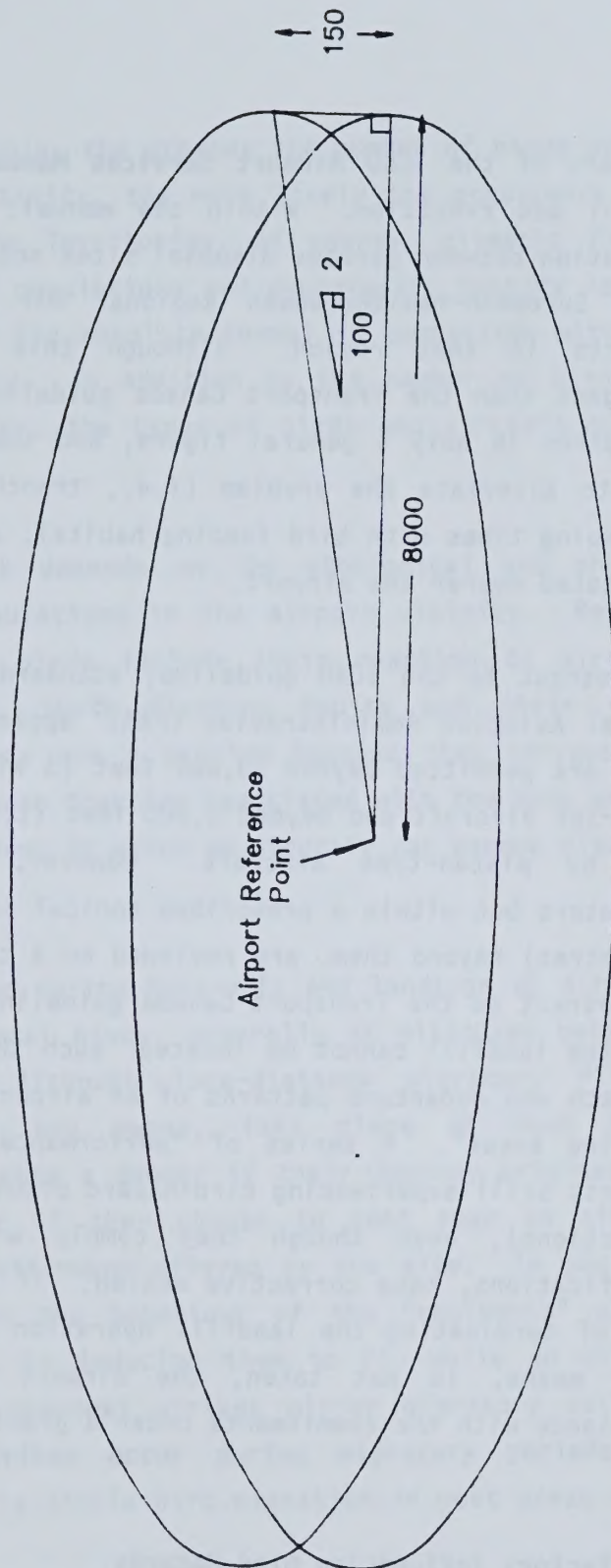
RESTRICTED AREAS FOR GARBAGE DUMPS



Source: Transport Canada, *Manual of Airport Bird Hazard Control*,
Ak-75-10-000, Airports and Construction (1983)

Exhibit 6

Geometric Basis for 8.0 Kilometer Separation Standard



Solid
Waste
Disposal
Permitted

All Dimensions In Metres

One part of the ICAO **Airport Services Manual**⁴ deals exclusively with bird control and reduction. Within the manual, reference is made to a 13 km separation between garbage disposal sites and airports, as recommended at the Sixth European-Mediterranean Regional Air Navigation Meeting (1971) for airports in that region. Although this suggested separation is more stringent than the Transport Canada guidelining, ICAO stresses that the 13 kilometres is only a general figure, and that if measures are taken at the site to alleviate the problem (i.e., trench burial of waste, coordination of dumping times with bird feeding habits), a waste disposal site can safely be located nearer the airport.

In contrast to the ICAO guideline, standards set out by the United States Federal Aviation Administration (FAA)⁵ appear to be more lenient. Landfill sites are permitted beyond 10,000 feet (3 kilometres) of any runway used by turbo-jet aircraft and beyond 5,000 feet (1.5 kilometres) of any runway used only by piston-type aircraft. However, any landfills outside these perimeters but within a prescribed conical surface extending 4,000 feet (1.2 kilometres) beyond them, are reviewed on a case-by-case basis. In addition, in contrast to the Transport Canada guidelines, the FAA guidelines stipulate that the landfill cannot be located "such that it places the runways and/or approach and departure patterns of an airport between bird feeding, water or roosting areas". A series of "performance" guidelines also ensures that airports still experiencing bird-hazard problems (as evidenced by regular FAA inspections), even though they comply with the distance and position specifications, take corrective action; if corrective action, either in the form of terminating the landfill operation or reducing the hazard by some other means, is not taken, the airport owner could be placed in non compliance with the commitments under a grant agreement.

5. Factors Influencing Bird Hazards

In general terms, setting aside the specific conditions encountered in the Northwest Territories, many factors affect the vulnerability of a given

⁵ U.S. Department of Transportation, **FAA Guidance Concerning Sanitary Landfills on or Near Airports**, Federal Aviation Administration (1974).

airport to bird hazards. Obviously, the greater the number of birds and the greater the level of airport activity, the more likely the occurrence of a bird-aircraft collision. In the Territories, of course, climatic factors result in relatively small bird populations and demographic factors lead to low levels of aviation activity (in absolute terms) in comparison with more developed regions of the country. In addition to the number of birds and aircraft traffic volumes, however, the types of birds and aircraft must be considered.

The degree of bird-hazard risk depends on the ethological and physical characteristics of the bird populations in the airport vicinity. Relevant ethological characteristics of birds include their reaction to aircraft, their familiarity with danger, their flocking habits and their flying altitude. Large flocks of birds are a problem because they increase the probability of a strike and because they are associated with the more serious multiple-ingestion type of accident in which an aircraft can become disabled, possibly resulting in a crash.

Since bird strikes usually occur during take-offs and landings at altitudes below 150 metres, flights of local birds, generally at altitudes below 200 metres, are most critical. Although long-distance migratory flights, particularly by ducks, geese and swans, take place at much higher altitudes, migrating birds also pose a danger if their journey originates or terminates near an airport, or if they choose to rest near an airport, attracted by the favourable environment offered by the site. In addition, visiting "transients" can upset the behaviour of the "residents" already accustomed to airport traffic, by inducing them to fly while an aircraft arrives or departs. In fact, seasonal strikes mirror migratory patterns: **50% of all Canadian bird strikes occur during migratory periods.** As discussed in Appendix I, there is little bird migration in most areas of the Northwest Territories.

Physical characteristics of birds, such as size, weight and flying ability, also determine the potential for bird-aircraft conflicts. Bird mass affects the impact force and the damage inflicted in a collision. In addition, birds

such as gulls, which take off slowly and have limited flying manoeuvrability present a higher risk than quicker, more manoeuvrable birds, such as wood pigeons.

The impact force generated by a collision is proportional to the mass of the bird and the square of the impact velocity. Thus, aircraft speed has an important bearing on the extent of possible damage, with the result that airports serving high-speed aircraft are at higher risk than those serving slower planes. In addition, the likelihood of collision increases because birds are less able to avoid high-speed aircraft. Turbine-jet aircraft are particularly vulnerable to bird strikes, because of their high velocities, their large frontal areas, and because of their tremendous air suction into turbine engine intakes which are prone to bird ingestion.

The vulnerability of an airport to bird hazards is increased where the site is attractive to bird flocks. Part 3 of the International Civil Aviation Organization (ICAO) **Airport Services Manual**⁶ suggests that birds may be attracted to airports:

- o to obtain food or water
- o to obtain shelter
- o for safety
- o because of an established migration or local movement route access to an airport
- o to find nests
- o for rest

In particular, the presence of a source of food and water in the airport vicinity is a major attraction for birds. Refuse containing food waste disposed of on or near the airport property encourages the congregation of

⁶ International Civil Aviation Organization, **Airport Services Manual** (1978).

scavengers such as gulls, starlings, crows, ravens, house sparrows, magpies, jackdaws, cowbirds and black kites. The significance of problems stemming from disposing of food wastes near airports is apparent when it is considered that up to 25% of bird strikes in Canada involve gulls and 8% involve sparrows, both common native scavenger birds.

Aside from edible garbage at nearby waste-disposal sites, other factors can attract birds to airports. These include earthworms and soil invertebrates driven out of their burrows after a rainfall and collecting on paved runways, and small bodies of water such as ponds, rivers, ditches and areas of poor drainage which supply drinking water and, especially if stagnant, support a thriving population of small fish, tadpoles, frogs, insect larvae and invertebrates as well as a variety of water vegetation. Grass, which often serves as the ground cover, is welcome food to intensive grazers such as pigeons and some geese. Since many varieties of small birds enjoy feeding upon seeds, caution must also be exercised with regard to agricultural use of the land on or near the airport site; in Canada, oats, corn and sunflowers have been singled out as crops most likely to attract birds. Finally, the grassy areas frequently surrounding runways and terminal buildings provide homes for rodents and rabbits which are hunted by predators such as owls and buzzards. Again, in relation to the climate and vegetation characteristics of most airports in the Northwest Territories, such factors are of considerably less importance than in other areas of Canada.

Although the airport site as a food source serves as the main bird attraction, other factors encourage birds to congregate near airports as well. Shelter is provided by airport buildings and by trees or shrubbery on or near the airport. While safety is related to shelter, the sense of security experienced by birds in vast open areas where they have a clear view of their surroundings and ample warning of any potential attackers, also contributes to the attractiveness of airport sites to birds. In this regard, again, most airports in the Northwest Territories do not offer such advantages in relation to surrounding areas as would generally be the case elsewhere in Canada.

The presence of birds due to migration or local movement routes across airports is simply a matter of coincidence where an airport has been constructed at a location previously used as a bird flyway. Several nesting possibilities have been exploited by birds at airports, including various parts of the terminal building, natural and excavated banks, dense grass and weeds and trees or shrubs. Finally, birds are drawn to the flat, open airport grounds as a convenient place to rest, since, apart from the aircraft itself, many of the factors that usually disturb birds (surface traffic, domestic animals, etc.) in urban environments are absent. Birds often enjoy resting on warm asphalt runways which retain heat better than the adjacent soil.

In analyzing the reasons why birds are drawn to airports, it is assumed that the attractions present in the vicinity of the airport are not available in the areas immediately outside these lands. For example, birds attracted to grassy fields at an airport located in the core of a highly developed urban area would not demonstrate the same preference for the airport if it were surrounded by similar grassy fields for miles around. The contrast - or rather lack of contrast - between an airport and its environs, is an important factor in assessing the propensity of birds to airports such as those in sparsely populated arctic communities where airport sites and their surroundings are environmentally very similar. As noted above, generally this lack of contrast is more prevalent in the Northwest Territories.

An examination of the bird hazards to aircraft in the Kitikmoet region, and in particular in five of its communities (Coppermine, Gjoa Haven, Holman, Pelly Bay and Spence Bay) is presented in Appendix A. Most of the information was obtained as part of this study. In general, it should be noted that there is little information available for NWT communities on bird population characteristics that would be of direct value to the solid waste site/airport separation requirement.

6. Control Measures

The most direct and effective means of reducing bird-strike hazards at airports is by eliminating or minimizing those factors which attract birds to airport sites. The presence of edible refuse is, in many cases, the main reason why the airport vicinity is so appealing to birds. Care should be taken, therefore, to locate waste disposal sites sufficiently far from runways to avoid interference with take-off and landing operations.

However, the **spatial relationship** between the airport, the waste disposal site and the birds' watering/roosting location is probably more important than the **separation distance** between the runway and the disposable site. If the waste disposal site and the watering/roosting location are situated on opposite sides of the airports, birds will fly across the airport at least twice a day, enroute from their watering/roosting site to their feeding site and then back again. A more favourable configuration occurs where the watering/roosting site is adjacent to the feeding site and both are well removed from runway activity.

In addition to spatial considerations, preventive measures can be taken at the disposal site in an effort to discourage the presence of birds. If waste is incinerated, buried and/or chemically treated, it will be of limited interest to birds. The most successful treatment programs coordinate collection, dumping and treatment with the daily schedule of the local resident bird population. For example, if gulls are accustomed to feeding on refuse during daylight hours, it is expedient to dump and bury refuse at night; when the hungry gulls arrive early the next morning, the waste is inaccessible and they must search elsewhere for food.

Other countervailing measures can be taken to diminish the desirability of the airport as a place of nourishment, shelter, protection and comfort for birds. Worms, grubs, insects, grasshoppers, crane flies and rodents consumed by birds can be controlled by chemicals. Replacing grass as a vegetable cover with a broad-leaved plant will drive away many of the insect species upon which birds thrive. Further, if the replacement vegetation does not

require the enriched soil necessary to support the growth of grass, earthworms also will not survive. If, for some reason, grass must be retained as vegetative cover, it should be grown taller than bird height, so as to block the birds' view of their surroundings and thereby discourage them from flocking to the airport grounds for security purposes.

Water in the vicinity of the airport, serving both as a drink for birds and as a medium for the aquatic life consumed by them, should be carefully controlled. Surface water should be eliminated as much as possible: ponds, pits and small depressions that tend to collect water during rainstorms and after spring thaw should be drained and filled in with a solid material. Drainage ditches should be unclogged, allowing water to flow freely and eradicating the organisms which thrive in stagnant water; also ditch banks should be mowed.

With respect to agriculture (not particularly relevant to airports in the Territories), controls can be implemented by not permitting agricultural leases on or near airport land and by distinguishing between acceptable and unacceptable crops in terms of bird attractability. Trees and brush offering food, protection, nesting sites and camouflages (also not particularly relevant in most regions of the Territories), can be removed from airport lands and fringes.

Airport buildings themselves can be designed such that they are not conducive to bird nesting: decorative holes and overhanging roofs in particular are to be avoided. Finally, in selecting sites for new airports, conflict with established migratory routes and compatibility with existing uses of adjacent land (with regard to bird hazards), should be taken into consideration.

Once all possible bird attractions have been removed from the airport and its vicinity, supplementary measures can be taken to "scare" birds and thereby disperse them or drive them off airport land. Some tactics that have been used with varying degrees of success include:

- o Activating pyrotechnic devices such as firecrackers, rockets, flares, shell crackers, etc.
- o Playing back tape recorded distress calls recognizable by the offending bird species.
- o Displaying dead or model birds in unusual positions, alongside the runways.
- o Flying kites or gliders resembling predator birds.
- o Training peregrine falcons to drive away other birds species.

If an intensive and exhaustive program to remove all bird attractions from the airport site is implemented and supplemented by dispersal strategies that have proven effective at a specific site, the bird-hazard problem will be eradicated in virtually every case; there is really no reason to kill, trap or otherwise harm the bird population near an airport.

7. Planning Implications

In selecting a waste disposal site which must be located near an airport, certain information is required in order to minimize potential bird hazards. Such information relates to:

- o the nature of aircraft traffic in terms of the number of daily aircraft movements at present, the number expected in the future, and the frequency of turbo-jet aircraft;
- o the density and habits of resident bird populations. Some characteristics of the resident bird population which should be studied include whether or not the birds are scavengers; the areas where they feed, water and roost; whether they are diurnal or nocturnal; the nature of their daily schedules, particularly with respect to flight paths; their ethological characteristics (flocking habits, excitability, altitude ranges) and physical characteristics (size, weight, flying ability). The existence and utilization of any established bird migration routes in the area should also be determined;

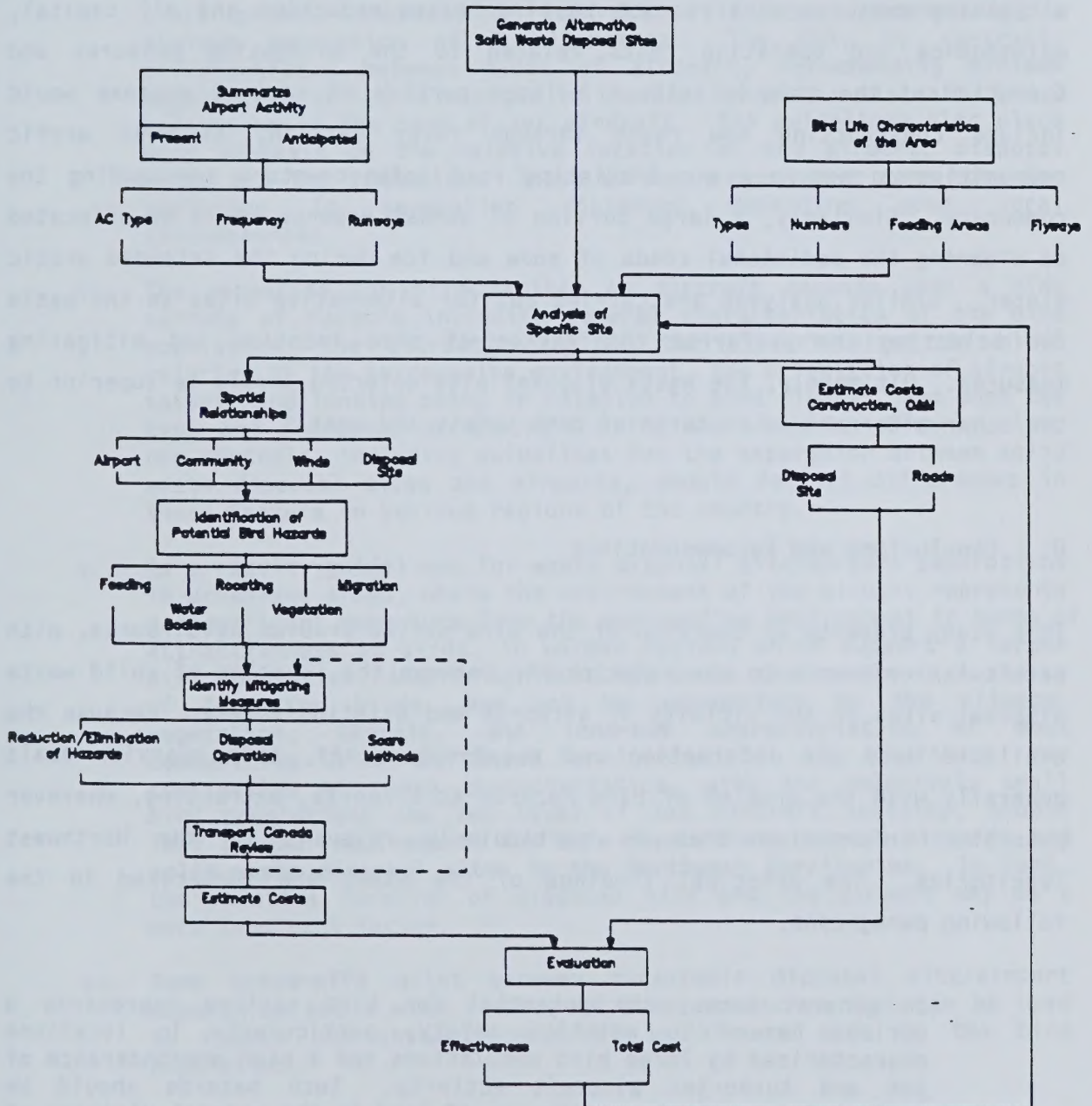
- o certain spatial relationships, namely the relative locations of the airport, population centres, water bodies, patches of vegetation, areas where birds feed, water and roost, and the proposed waste disposal sites, as well as the orientation of runways and the direction of the prevailing winds.

The preferred approach to waste disposal site selection involves generating a number of alternative sites for assessment before selecting the most feasible candidate. Transport Canada endorses this approach and is, in fact, willing to assist in the appraisal of alternatives. In locales where the bird density is low, where airports are infrequently used, and where few or no turbo-jet aircraft use the airport, the separation between solid waste disposal sites and airports needed to ensure safe operation should be considerably less than the current 8 km guideline, particularly if measures are implemented to render both the waste disposal site and the airport unattractive to the relatively small bird population. Such measures, as previously discussed, include drainage and fill of water bodies on or near the airport, vegetation control, incineration, burial and/or chemical treatment of waste, and the dispersal of birds by various "scaring" procedures.

A general approach for assessing potential bird hazards and possible mitigating measures can be described as in the accompanying flow diagram (Exhibit 7). The process begins by identifying potential solid waste disposal sites, summarizing activity data for the specific airport, and obtaining relevant information for birds that are characteristic to the area. For each candidate waste disposal site, spatial relationships involving the relative locations of the disposal site, the airport and the community are examined as the basis for determining potential bird hazards in relation to aircraft flight patterns. At the same time, a cost analysis of the candidate disposal site can also be carried out.

Once potential sources of bird hazards are identified for the candidate site, a variety of mitigating measures can be formulated, ranging from eliminating the potential attractiveness of certain topographical features (small bodies of water, patches of vegetation, etc.) through procedures for controlling

Exhibit 7



disposal operations (time of day, covering) to bird scare tactics. At this point, it would be appropriate to review the effectiveness of these measures with Transport Canada and to consider any additional measures that might emerge as a result of the review process, before proceeding to the cost estimation stage.

Finally, each candidate site is evaluated in terms of the effectiveness of mitigating measures with respect to bird-hazard reduction and all capital, maintenance and operating costs related to the mitigating measures and operation of the disposal site. A large portion of capital expense would include constructing new roads through rocky terrain, as most arctic communities do not have a pre-existing road infrastructure surrounding the community. Similarly, a large portion of annual expense would be allocated to clearing the additional roads of snow and ice during the extended arctic winter. Similar analyses are carried out for alternative sites as the basis for selecting the preferred combination of site location and mitigating measures. Ultimately, the waste disposal site selected should be superior to the other alternatives in terms of both safety and cost.

8. Conclusions and Recommendations

This study presents an overview of the bird-strike problem at airports, with particular reference to the relationship between the location of solid waste disposal sites in the vicinity of airports and aviation safety. Because the available data and information are relatively scant, this overview deals generally with the problem of bird hazards at airports, extracting, wherever possible, information that is particularly relevant to the Northwest Territories. The principal findings of the study are summarized in the following paragraphs.

- i. In general terms, the potential for bird strikes represents a serious hazard to aviation safety, particularly in locations characterized by large bird populations and a high preponderance of jet and turbo-jet aircraft activity. Such hazards should be reflected in controls on the use of land in the general vicinity of airports so as to minimize the attractiveness of airport sites to the bird population.

- ii. In particular, because of the attractiveness of solid waste disposal sites as sources of food for bird populations, special consideration must be given to the separation between such sites and airports. In fact, a number of organizations concerned with aviation safety, including Transport Canada and the U.S. Federal Aviation Agency, have developed specific guidelines to deal with this problem.
- iii. There are some notable differences in guidelines formulated by different agencies. Transport Canada guidelines, for example, place greater emphasis on separation distances, recommending a minimum separation of 8 kilometres. The FAA, by contrast, differentiates between types of aircraft, recommending minimum separations of 1.5 kilometres in the case of piston aircraft, and 3 kilometres in the case of jet aircraft. FAA guidelines also place more emphasis on the relative location of the airport, disposal site, and the community. These differences suggest some room for variation in separation distances depending upon local circumstances.
- iv. The potential for bird strikes on aircraft depends upon a wide variety of factors including general characteristics of the bird population, the attractiveness of the airport sites to birds relative to the surrounding environment, the orientation of airport takeoff and landing paths in relation to bird flyways, and both the type and frequency of aircraft using the airport. Clearly, land use controls, including guidelines for the separation between solid waste disposal sites and airports, should reflect differences in these factors in various regions of the country.
- v. As a result, guidelines for waste disposal site/airport separations in urbanized areas, where the environment of the airport represents a significant departure from the surrounding environment in terms of attractiveness to birds, in warmer regions which support a larger bird population, and in agricultural areas that serve as a source of food for birds, **may not be appropriate to the climate, vegetation, terrain, and land-use characteristics of most communities in the Northwest Territories.** In all likelihood, the combination of these characteristics, with the relatively small bird populations and low level of jet aircraft activity, should lead to **new requirements for safe separations between airports and solid waste disposal sites in the Northwest Territories.** In fact, the relative location of disposal site and the airport may be a more important factor.
- vi. Some trade-offs exist between acceptable disposal site/airport separation and a wide variety of countermeasures that can be used to reduce the attractiveness of an airport site to the bird population.

- vii. For the Northwest Territories, as well as other regions with similar climatic, topographical, and demographic characteristics, where bird populations are relatively small, there is a need to develop guidelines for the separation between solid waste disposal sites and airports, including related countermeasures which reflect the specific conditions encountered in these regions.
- viii. In view of the Northwest Territories' unique circumstances, it would be expedient to implement a guideline which combines separation distances with spatial considerations (taking into account conflicts between bird flyways and aircraft flight paths), and with performance criteria (whereby remedial action would have to be taken if airport safety proved to be substandard as a result of bird-strike hazards associated with disposal sites). These guidelines, although different than those applying to other parts of Canada, would not necessarily be less stringent.
- ix. At present, the development of such guidelines is impeded to some extent by the limited data available on site-specific bird population characteristics, as well as by statistics on bird strikes for many of the airports in the Northwest Territories that are presently not part of the Transport Canada incident-reporting system.

On the basis of these findings and other material presented in this report, and recognizing the relatively scant data available at the present time pertaining to specific airport sites in the Northwest Territories, the following **recommendations** are made:

- i. The government of the Northwest Territories should develop guidelines for the separation between solid waste disposal sites and airports that are relevant to conditions encountered in various regions of the Northwest Territories.
- ii. Rather than developing a single guideline for the Territories, the new guidelines should be flexible and multi-faceted, taking into account a number of different criteria, including assurances that any resultant bird hazards will be dealt with by a variety of measures such as improved waste disposal operations and bird-management procedures, reducing the local bird population.
- iii. To facilitate the development of such guidelines, the data base on incidents involving bird strikes on aircraft at Northwest Territories airports should be improved. The Arctic Airports Division of NWT Transport should be asked to prepare, from their records, and in cooperation with NWT air carriers, the past experience of bird/aircraft strikes. This information will be of great value in distinguishing between high, medium and low-risk regions/communities, taking into account any future changes in aircraft movements at communities.

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- iv. NWT Renewable Resources - Wildlife Service should be asked to design a project to provide information for high-risk regions/communities on bird-population characteristics near airports. This information would be a valuable addition to the limited data currently available.
- v. The Government of the Northwest Territories, through the Department of Municipal and Community Affairs and other departments directly involved, should negotiate now with Transport Canada for the establishment of interim guidelines for the separation of solid waste disposal sites from airports in NWT communities, on the basis of this study and information which will become available from action taken in Recommendations iii and iv above.
- vi. The Government of the Northwest Territories, through its Transportation Department, should develop a bird-strike reporting system for airports in the Northwest Territories, similar to the reporting system now used by the Airports Authority Group of Transport Canada, but tailored to the specific needs of the Territories. If information developed in actions on Recommendation iii so indicate, such a system may be needed only in high-risk regions/communities.
- vii. After development of information resulting from action on Recommendations iii, iv, v and vi over several years, the interim guidelines should be reviewed and revised appropriately.

APPENDIX A

At the start of this study (January 1988), there was particular concern to investigate five communities in the Kitikmeot region because it was expected that remedial work or relocation of solid waste disposal facilities might be required. The work reported below is based on factual information available in early 1988. Changes may have occurred since, but are not reported here.

APPENDIX A-1

Bird Hazards in the Kitikmeot Region

In Section 5, the general reasons that birds frequent airport lands are outlined to show what factors should be taken into account in considering locations for solid waste disposal sites. Some of these factors may be of considerably less importance in the Northwest Territories than elsewhere in Canada. This section examines these key factors in relation to the Kitikmeot region of the Northwest Territories where a number of new solid waste disposal sites have been proposed. Additional detail on five specific sites shown in Exhibit A-1, namely, Coppermine, Gjoa Haven, Holman, Pelly Bay and Spence Bay is provided in Appendix A-2. The Gjoa Haven waste disposal site has already been in operation for two years, while the disposal sites for the other four communities are in the planning stage.

In assessing the location of disposal sites in this region from the standpoint of bird hazards to aircraft, it is useful to have a basic knowledge of community demographics, geography and climate, waste disposal methods, aircraft traffic, resident and migratory bird populations as well as the spatial relationships between the airport, proposed waste disposal site and bird roosting locations. A number of conditions common to all five communities can be explored on the basis of the summary information shown in Exhibit A-2. For each community, this exhibit summarizes the general comparisons that are covered in the following paragraphs. Data is provided on community location, climate, vegetation and topography, solid waste disposal operations and airport activity. More detail on current solid waste disposal methods is provided in Appendix A-2.

Community Location



Source: Survey and Mapping, Department of Municipal and Community Affairs, Government of the Northwest Territories

Exhibit A-2

Community Characteristics

	Cape Sabine	Glen Haven	Helman	Pelly Bay	Spence Bay
<u>Location</u>					
Latitude	67°50'N	66°53'N	70°43'N	66°32'N	60°32'N
Longitude	116°16'W	96°50'W	117°46'W	66°46'W	96°32'W
<u>Population</u>					
1988	608	650	303	297	466
Anticipated Growth Rate	3.10%	2.60%	2.87%	1.90%	3.19%
2000 (Projection)	1362	919	461	391	758
<u>Climate</u>					
Coudest Month Means:	February	January	January	February	January
High	-27°C	-23°C	-26°C	-30°C	-30°C
Low	-36°C	-49°C	-32°C	-38°C	-38°C
Warmest Month Means:	July	July	July	July	July
High	13°C	24°C	11°C	10°C	12°C
Low	6°C	7°C	4°C	3°C	3°C
Annual Rainfall (mm)	92	84	77	104	72
Annual Snowfall (mm)	602	254	853	874	1191
<u>Vegetation and Topography</u>					
Vegetation	Grasses, sedges, heather, mosses, lichens; willow and alder thickets in wet depressions.	Lichens on rocks and outcrops; stunted arctic willows in sheltered areas.	Limited vegetal cover; lichens, coarse grasses, stunted shrubs.	Rock and till sparsely covered with mosses and lichens.	Lichens, mosses and willow mats; grasses, sedges in poorly drained depressions.
Geological Characteristics	Steep outcrops of dolomite and shale underlain by preambrian sedimentary and volcanic rock.	Limestone bedrock covered with thin veneer of frost-weathered in-situ sand and boulders; hills to 45m.	Series of raised gravel beaches underlain by volcanic bedrock; massive gabbro escarpment and outcrops.	Huge outcrops of preambrian rock; extensive granular deposits in valleys between rock ridges.	Boulder glacial till underlain by preambrian granites and gneisses; sandy gravel spher west of community.

Exhibit A-2 (cont'd)

Community Characteristics

	Capacities	Olson House	McNair	Polly Bay	Spence Bay
Solid Waste Disposal Operations					
Proposed Disposal Method	Modified Landfill	Modified Landfill	Modified Landfill	Modified Landfill	Modified Landfill
Number of Annual Burials	1	2	1	2	1
Burning	On-site	None	Maybe	None	On-site
Per Capita Waste Production (m ² /day)	0.0105	0.0100	0.0101	0.0102	0.0105
Airport Activity					
Annual Aircraft Movements:					
1982	-	544	515	807	723
1983	2154	563	534	581	872
1984	1955	761	879	582	558
1985	1859	791	709	708	902
1986	1880	823	884	887	699
2000 (Projection)	2577	1153	1033	1181	1085
1985 Itinerant Movement Power Plant Types:					
Jet	1	0	0	2	0
Turbo-Propeller	1091	180	432	375	247
Piston	472	625	231	514	438
Helicopter	116	7	23	5	10
1985 A/C Movements Per Capita:	1.9	1.3	2.3	3.0	1.4
Runway Type					
Runway Dimensions (m length by m width)	Gravel	Gravel	Gravel	Gravel/Clay	Gravel
	1524 x 30	1341 x 30	1311 x 30	1311 x 30	1100 x 30

Population

All communities are Hamlets with 1986 populations ranging from approximately 300 to 900. Using anticipated growth rates, populations for these communities are expected to range from about 400 to 1,400 by the year 2000. With the exception of Coppermine, where oil exploration is an important means of employment, the major sources of income are from hunting, fishing and trapping, and from handicrafts such as carving and sewing. Municipal, Territorial and Federal Government employees also reside in the communities, as do those engaged in seasonal summer construction work.

Climate

The Kitikmeot Region of the Northwest Territories is north of the Arctic Circle within the region of continuous permafrost, where earth materials such as rock and soil are at temperatures below 0⁰ Celcius on an uninterrupted plane beneath the surface year round. The depth of the active layer at the end of the summer ranges from about one-half metre to one metre. For those northern latitudes, temperatures are quite low. Discounting Gjoa Haven, which has a rather extreme temperature range, coldest month mean temperatures range from -30⁰ Celsius to -25⁰ Celsius (highs) and from -38⁰ Celsius to -31⁰ Celsius (lows), and warmest month mean temperatures range from 10⁰ Celsius to 13⁰ Celsius (highs) and from 3⁰ Celsius to 5⁰ Celsius (lows).

Vegetation and Topography

Rugged climatic conditions have an effect on the type of vegetation that can thrive. The five communities belong to the arctic tundra vegetation region. Here, soils are churned by frost action, and low temperatures inhibit the decay of organic matter. The short growing season is also limited by continuous permafrost which retards plant growth and prevents deep root penetration. Consequently, much of the vegetation tends to be low and compact in order to trap radiant energy. Lichens and mosses are common tundra plants, supplemented by grasses, sedges, and willow and alder thickets which grow in the more poorly drained depressions. -

The region is characterized by rugged, rocky terrain and a relative scarcity of finer soil materials that are suitable for fill and construction. These

factors, together with the continual presence of permafrost, make road construction extremely difficult. In part, this explains the compactness of the typical arctic community where residences, community buildings, the airstrip, water resources and sewage and waste disposal sites are virtually side-by-side against the coastline.

Due to sparse vegetation and poor rocky soil characteristics of this region, certain factors which attract birds to airport vicinities further south can be ruled out. For example, food sources such as grass are not abundant in the north, and agricultural seed crops such as oats, corn and sunflowers are non-existent. Since the soil is not rich in organic matter, earthworms do not thrive. In addition, trees and shrubbery, typically providing shelter for various bird species in southern regions, are again absent in the far north.

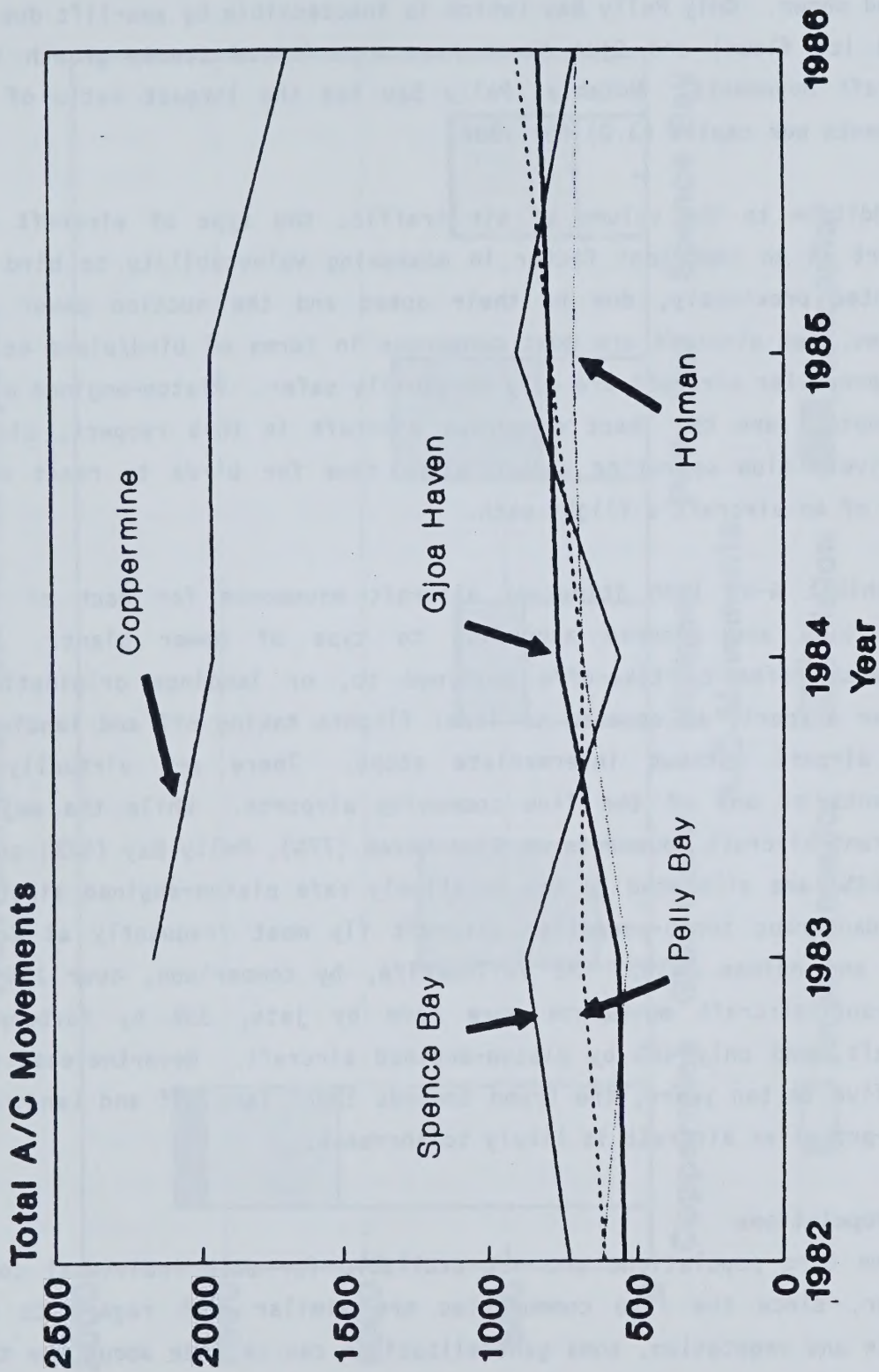
Airport Activity

The community airports considered here are very modest in scale. Only Coppermine has a flight service station; the other four operate without air traffic control towers. Each airport has a single gravel or gravel and clay runway ranging in length from 1,100 to 1,524 metres. All are operated by the Government of the Northwest Territories. No bird strikes have been reported at any of the five airports; however, the lack of records could be more indicative of deficient strike reporting programs than the absence of bird strike incidents.

As evident from Exhibit A-3, which shows total annual aircraft movements from 1982 to 1986, volumes of air traffic are very light at all five community airports. Coppermine's aircraft movements are in the range of 2,000 per year, and those of the other communities are well under the 1,000 per year level. By comparison, Yellowknife Airport supports over 47,000 aircraft movements annually.

In general, growth rates for aircraft activity at these airports have been sporadic. Annual aircraft movements at Coppermine and Spence Bay have actually declined, while at Holman they have fluctuated within the five-year

Total Aircraft Movements Five Northwest Territories Airports



Source: Transport Canada, *Aircraft Movement Statistics; Annual Report (1986)*.

period shown. Only Pelly Bay (which is inaccessible by sea-lift due to year-round ice flows) and Gjoa Haven have experienced steady growth in annual aircraft movements. Notably, Pelly Bay has the largest ratio of aircraft movements per capita (3.0) for 1986.

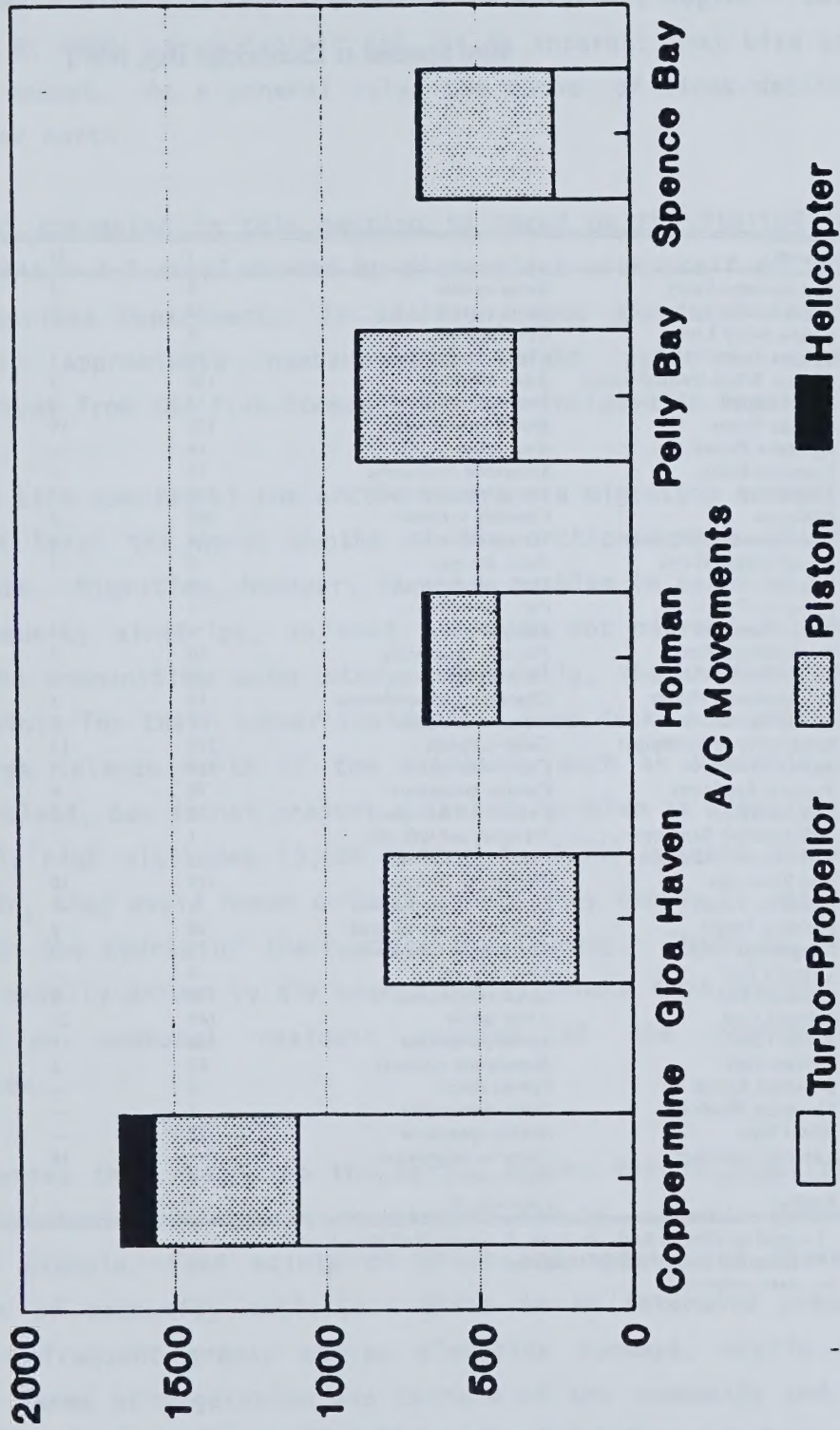
In addition to the volume of air traffic, the type of aircraft using an airport is an important factor in assessing vulnerability to bird hazards. As noted previously, due to their speed and the suction power of their engines, jet aircraft are most dangerous in terms of bird/plane collisions. Turbopropeller aircraft are only marginally safer. Piston-engined planes and helicopters are the least dangerous aircraft in this respect, since their relatively slow operating speeds allow time for birds to react and steer clear of an aircraft's flight path.

In Exhibit A-4, 1986 itinerant aircraft movements for each of the five communities are grouped according to type of power plant. Itinerant movements refer to take-offs destined to, or landings originating from, another airport, as opposed to local flights taking off and landing at the same airport without intermediate stops. There are virtually no jet movements at any of the five community airports. While the majority of itinerant aircraft movements at Gjoa Haven (77%), Pelly Bay (57%) and Spence Bay (63%) are allocated to the relatively safe piston-engined aircraft, the more dangerous turbo-propeller aircraft fly most frequently at Coppermine (65%) and Holman (63%). At Yellowknife, by comparison, over 13% of 1986 itinerant aircraft movements were made by jets, 33% by turbo-propeller aircraft, and only 48% by piston-engined aircraft. Nevertheless, over the next five to ten years, the trend towards Short Take Off and Landing (STOL) turbo-propeller aircraft is likely to increase.

Bird Populations

Data on bird populations are not available for each individual community. However, since the five communities are similar with regard to climate, terrain and vegetation, some generalizations can be made about the types and numbers of resident and migratory birds likely under such conditions. A rough idea of bird species and their relative densities are shown in Exhibit

1986 Itinerant Movements by Type of Power Plant Five Northwest Territories Airports



Source: Transport Canada, *Aircraft Movement Statistics; Annual Report (1986)*.

Exhibit A-5

Bird Species at Cambridge Bay, NWT

Species		I	II	Clutch sizes
Red-throated Loon	<i>Gavia stellata</i>	3	1	1x1
Arctic Loon	<i>Gavia arctica</i>	14	3	2x2
Yellow-billed Loon	<i>Gavia adamsii</i>	5	—	—
Tundra Swan	<i>Cygnus columbianus</i>	48	1	1x3
Greater White-fronted Goose	<i>Anser albifrons</i>	130	5	1x2, 2x3, 2x5
(Black) Brant	<i>Branta bernicla</i>	12	2	1x5
Canada Goose	<i>Branta canadensis</i>	170	19	7x4, 1x5, 1x6
Northern Pintail	<i>Anas acuta</i>	14	—	—
Common Eider	<i>Somateria mollissima</i>	12	—	—
King Eider	<i>Somateria spectabilis</i>	340	3	1x2, 1x3, 1x5
Oldsquaw	<i>Clangula hyemalis</i>	260	2	1x4*, 1x7
Red-breasted Merganser	<i>Mergus serrator</i>	14	1	1x6
Rough-legged Hawk	<i>Buteo lagopus</i>	6	1	1x3
Merlin	<i>Falco columbarius</i>	1	—	—
Peregrine Falcon	<i>Falco peregrinus</i>	1	—	—
Rock Ptarmigan	<i>Lagopus mutus</i>	4	—	—
Black-bellied Plover	<i>Pluvialis squatarola</i>	60	1	1x4
Lesser Golden-Plover	<i>Pluvialis dominica</i>	140	2	2x4
Semipalmated Plover	<i>Charadrius semipalmatus</i>	10	1	1x4
Ruddy Turnstone	<i>Arenaria interpres</i>	75	1	1x4
Semipalmated Sandpiper	<i>Calidris pusilla</i>	210	11	1x3, 10x4
Baird's Sandpiper	<i>Calidris bairdii</i>	110	10	10x4
Pectoral Sandpiper	<i>Calidris melanotos</i>	70	6	6x4
Silt Sandpiper	<i>Calidris himantopus</i>	120	2	2x4
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	1	—	—
Red-necked Phalarope	<i>Phalaropus lobatus</i>	3	—	—
Red Phalarope	<i>Phalaropus fulicaria</i>	175	10	1x3, 9x4
Pomarine Jaeger	<i>Stercorarius pomarinus</i>	6	—	—
Parasitic Jaeger	<i>Stercorarius parasiticus</i>	26	2	1x2
Long-tailed Jaeger	<i>Stercorarius longicaudus</i>	72	3	1x1, 1x2
Thayer's Gull	<i>Larus thayeri</i>	9	—	—
Glaucous Gull	<i>Larus hyperboreus</i>	170	2	—
Sabine's Gull	<i>Xema sabini</i>	140	21	3x1, 3x2, 2x3
Arctic Tern	<i>Sterna paradisaea</i>	160	13	1x1, 2x2
Horned Lark	<i>Eremophila alpestris</i>	85	1	1x3
Common Raven	<i>Corvus corax</i>	1	—	—
Mountain Bluebird	<i>Sialia currucoides</i>	1	—	—
Water Pipit	<i>Anthus spinoletta</i>	12	—	—
Lapland Longspur	<i>Calcarius lapponicus</i>	++	18	2x4, 11x5, 4x6, 1x7
Snow Bunting	<i>Plectrophenax nivalis</i>	70	—	—
Redpoll	<i>Carduelis sp.</i>	3	—	—

I--total number of birds observed II--number of nests found

*--in nest of Red-breasted Merganser

++--very common

Source: C.M. Lok and J.A.J. Vink, "Birds at Cambridge Bay, Victoria Island, Northwest Territories, in 1983", The Canadian Field-Naturalist, 100-3 (July - September 1986).

A-5, which lists, by species, the total number of birds observed near Cambridge Bay - also a coastal community in Kitikmeot Region - between June 23 and July 6, 1983. From Exhibit A-5, it is apparent that bird populations are rather modest. As a general rule, the number of birds declines as one moves further north.

The material presented in this section is based on the limited information shown in Exhibit A-5 supplemented by discussions with staff of the Canadian Wildlife Services Department. In addition, some anecdotal information on bird types, approximate numbers and flight patterns, supplied by representatives from the five communities, are included in Appendix A-2.

Most of the bird species of the arctic tundra are migratory summer residents, spending at least the worst months of the arctic winters south of their summer roosts. Migration, however, is not a problem in terms of bird strikes at the community airstrips, as most birds do not migrate to destinations north of the communities under study. Generally, the communities serve as route endpoints for their summer residents. Some ducks and geese do migrate to the large islands north of the mainland, such as Victoria Island and Ellesmere Island, but do not present a serious problem at airports: they fly at extremely high altitudes (3,000 metres to 6,700 metres) over the ocean and, further, they avoid human contact should they happen to rest close to a community in the course of their migratory journey. There is no east-west migration, usually driven by the search for alternate food sources, by either year-round or seasonal resident species of the communities under consideration.

Certain species that reside in the arctic tundra for at least part of the year pose virtually no threat to airport safety. Canada geese and snow geese, for example, feed mainly on grass and sedge, and thereby can be independent of community activity. While in an intensive urban setting, geese would frequent grassy strips alongside runways, arctic airports - uniform in terms of vegetation and terrain of the community and the barren lands beyond - do not represent preferred feeding sites for geese. Seabirds such as eiders and terns which are also present in relatively large numbers, also keep clear of the community, nesting dispersedly on small off-shore

islands and feeding on coastal fish. Finally, dry land pond birds like plovers and sandpipers deserve mention. While these birds may linger at ponds near airstrips, they do not present much potential for interfering with aircraft operations because of their small numbers and because they do not flock.

Two types of scavengers are possible candidates for bird-aircraft collisions: gulls and ravens. Like most arctic tundra birds, gulls are summer residents, inhabiting the communities under study from May to September. Their primary food source is domestic refuse from waste disposal sites. Because gulls tend to travel in large groups, in the event of a collision, aircraft are vulnerable to serious multiple ingestion-type accidents which often cripple their engines. In the case of gulls, flyways are created between community roosting sites and waste disposal sites and, to a lesser degree, between resting locations along the coast or in cliffs and waste disposal sites. Certainly, gull flights will cover paths other than the straight line community-disposal site and coast-disposal site connections, but the probability of finding the greatest number of birds at any time will be highest along these flyways. Care must be taken, then, that gull flyways do not intersect aircraft flight paths which, at short distances from airports, can be taken to be in alignment with the runways.

Unlike gulls, which only present a bird hazard problem in the summer, ravens are more hazardous in winter. Due to large body size (less body surface area per unit mass than for smaller birds), and thick covering of feathers and relatively high percentage of body fat, ravens are able to endure harsh arctic winters. During the summer, they disperse into the tundra fields to raise their young; however, in winter, about 100 to 200 ravens congregate back to the community in search of warmer micro-climates, protecting themselves from the elements by roosting around buildings, on elevated perches, etc. As for gulls, the waste disposal site is their primary in-community food source. Since ravens are not aquatic, only the path connecting community roosting areas and the waste disposal feeding site is of concern and should not interfere with airstrip flight plans.

APPENDIX A-2

Case Studies of Solid Waste Disposal Sites in the Kitikmeot Region of the Northwest Territories

1. Methods of Solid Waste Disposal

Due to the non-industrialized nature of community life in the five communities under study, most of the waste collected can be classified as domestic waste. Arctic climatic conditions and terrain dictate the types of solid waste disposal operations that are reasonable. Four main methods of waste disposal are used, namely:

- i. Sanitary landfill
- ii. Modified landfill
- iii. Incineration
- iv. Composting

Sanitary landfills, which involve dumping and burying waste on a regular (usually daily) basis, would not be feasible for the communities studied here, since the requisite daily covering of waste cannot be obtained from the minimal amount of fill material accessible via the road system. Modified landfill operations, requiring only monthly or seasonal covering, seem to best suit the needs of arctic communities. The small quantity of waste generated by 300 to 900 people (at about 0.01 cubic metres per capita per day) further justifies using the modified landfill method.

Incineration involves burning solid waste as it is deposited at the site. Due to capital and operating costs as well as requirements for on-site supervision in preventing windblown ash during covering operations, incineration is not usually suitable for small-scale disposal operations. Moreover, unless combined with a waste heat recovery project where a demand exists for the energy recovered, it is generally expensive.

Composting, which involves the aerobic breakdown of waste by bacteria into organic matter, is also inappropriate for the communities considered here.

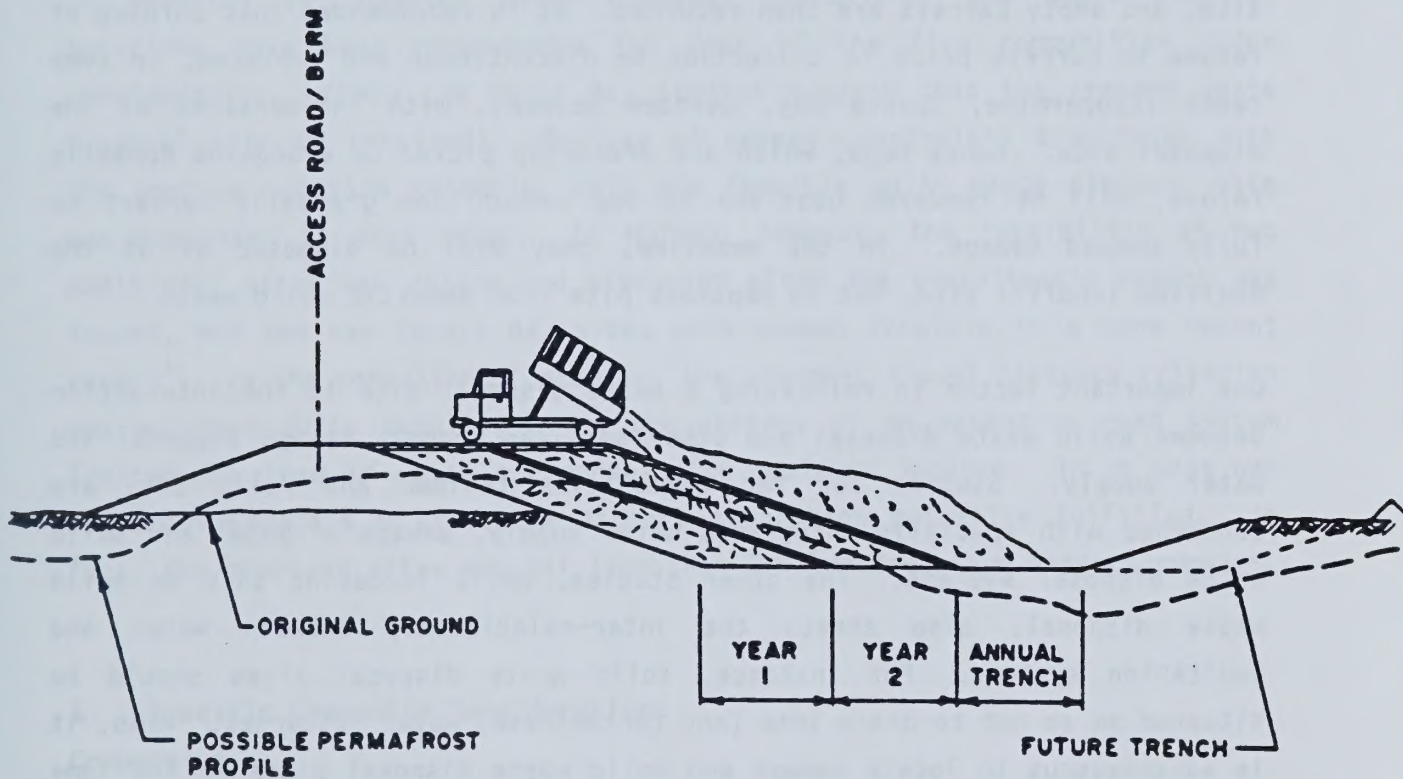
Bacteria present in composts are only active at temperatures above freezing and would require enormous amounts of heat energy throughout most of the year. Again, a high level of operator attention is required. In addition, for these locations, there would be little demand for composted refuse which is useful as a fertilizer in more temperate climates.

A typical modified landfill operation is pictured in Exhibit A-6. Refuse is unloaded from a berm (of slope 1:3 or 1:2) into a pit. Some communities prefer incinerating the waste on-site to reduce volumes by 50% to 60%, while other communities discourage waste burning due to resultant smoke, toxic fumes from plastics and explosions of aerosol cans and propane cylinders. At most modified landfill sites, however, waste is compacted; the volume of unburned refuse can be reduced by a ratio of 5:1 or more if tracked equipment for compaction is available. Compacted waste will not settle as much as uncompacted waste, so aside from reducing waste volume, compaction facilitates future site maintenance.

While traditional modified landfill operations work well under temperate climatic conditions, problems have been experienced in the Arctic. As a result of snow expansion, cold weather waste disposal trenches tend to fill up much more quickly than forecasts predict. In winter, each layer of disposed waste becomes covered with a layer of snow. Because the waste acts as protective insulation to the snow, some of the snow near the bottom does not melt during the brief summer season. In addition, the road surfaces formed after compaction tend to be rough and bumpy, due to the melting of submerged ice pockets. A variant of the modified land-fill method, whereby waste is dumped at one location within an area enclosed by berm walls, spread over the entire walled area to drain and dry, then pushed against the wall opposite the dumping location and covered, would likely be more appropriate for Northwest Territories communities.

Exhibit A-6

Modified Landfill Operation



Source: Roland Welker, Pelly Bay, N.W.T.: Final Landfill Design and Operations Concept Report, G.C.G. Dillon Consulting Limited. (March, 1986).

2. Recent Studies

A number of recent studies (cited in the following section), addressing the issues of where to locate and how to operate 20-year-capacity waste disposal sites at Coppermine, Gjoa Haven, Holman, Pelly Bay and Spence Bay all recommend that modified landfill waste disposal operations be implemented. While these studies all call for an overhaul of waste disposal operations, they propose that, by and large, the present collection methods be retained. Domestic refuse is deposited in old fuel drums placed in front of each residence, full barrels are collected by trucks and emptied at the disposal site, and empty barrels are then returned. It is recommended that burning of refuse in barrels prior to collection be discontinued and replaced, in some cases (Coppermine, Spence Bay, perhaps Holman), with incineration at the disposal site. Honey bags, which are presently picked up alongside domestic refuse, will be rendered obsolete as the communities gradually convert to fully pumped sewage. In the meantime, they will be disposed of at the modified landfill site, but in separate pits from domestic solid waste.

One important factor in relocating a waste disposal site is the interaction between solid waste disposal and other services, namely sewage disposal and water supply. Studies for two communities (Holman and Pelly Bay) are concerned with spatially integrated water supply, sewage disposal and solid waste disposal systems. The other studies, while focussing only on solid waste disposal, also stress the inter-relationship between water and sanitation systems. For instance, solid waste disposal sites should be situated so as not to drain into (and contaminate) water resources. Also, it is advantageous to locate sewage and solid waste disposal sites in the same vicinity, allowing for the confinement of problematic wastes and for the reduction of access road costs.

Considerations other than interaction with water supply and sewage disposal functions and interference with airstrip operations also influence decisions on the location of solid waste disposal sites. These include:

- o Economic travel distance.
- o Visual concealment from community.
- o Distance from community sufficient to avoid smoke and odour problems.
- o Accessibility of earth cover.
- o Minimal environmental impacts to land, water, birds and animals.

In addition to changing waste disposal operations, new waste disposal locations have been recommended for four of the five communities under consideration. (Only the Pelly Bay studies suggest that the present waste disposal site be retained). Because of severe constraints associated with the various location criteria, only one feasible solid waste disposal site was suggested in each study. In Holman, however, the feasibility of two additional sites was raised and discussed after the consultant's report was issued, and two new Spency Bay sites were deemed feasible in a more recent report¹. In the consultants' studies, the economic travel distance criterion was weighted quite heavily, since the absence of an extensive road system limited the area in which a disposal site could be located. In no case was Transport Canada's 8 kilometre airport separation guideline fulfilled; in fact, the proposed sites are all less than 2 kilometres from airport runways.

3. Specific Community Considerations

Coppermine

Source Document:

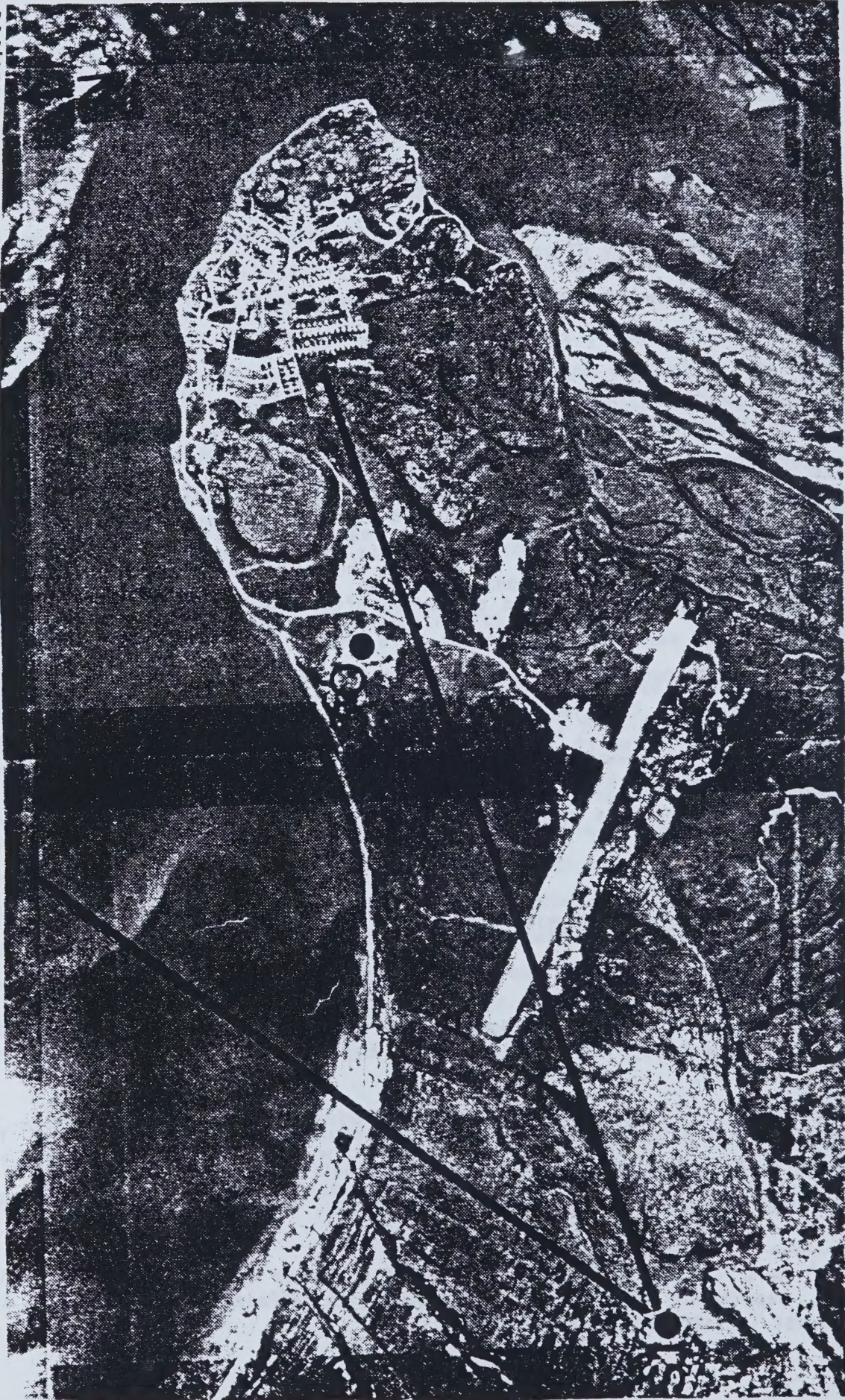
R. E. K. Feilden and Norman C. Gridley, **Solid Waste Disposal Study; Coppermine, N.W.T.**, Associated Engineering Services Ltd. (March, 1981).

Coppermine is situated on a bedrock exposure on the west bank of the Coppermine River where it empties into Coronation Gulf. Exhibit A-7 is an aerial map of Coppermine, showing the community, the airstrip and the current

¹ Karu Chinniah, **Spence Bay, N.W.T.; Water and Sanitation Planning Study**, Department of Municipal and Community Affairs, Government of the Northwest Territories, January, 1987.

Coppermine

1:20,000



- S0 - Existing Waste Disposal Site
- S1 - Proposed Waste Disposal Site
- A - Airstrip
- C - Community

— Bird Flyway

Source: Survey and Mapping Department of Municipal and Community Affairs, Government of the Northwest Territories

and proposed waste disposal sites. The present waste disposal site is considered inadequate due to its visibility from the airport road, its separation of only 1.0 kilometre from the airstrip and its drainage directly into Coronation Gulf.

In selecting an alternate location for solid waste disposal, the consultant noted that terrain was a limiting factor. Thick beds of sedimentary and volcanic bedrock, dipping to the north and exposing south facing scarps, cover the Coppermine area. Apart from the airport (which is located in a flat valley), and the town (which lies on a thick mantle of coarse river deposits), the ubiquitous bedrock tends to be weathered, rugged and difficult to penetrate with roads. Areas to the east and south of the community are rejected as sites, due to potential contamination of the Coppermine River, the community's water supply source. Coronation Gulf is immediately north of the community, with the result that only land west of the community can be used for waste disposal purposes. Lands northeast and southwest of the airport again are poorly drained, and could contaminate the Coppermine River during the spring freshet. Only sites west of the airport, then, can be reasonably considered.

The site proposed by the consultant is a 61-metre gorge with bedrock walls that could serve as control structures. The gently sloping sand base drains naturally to the sea, ensuring that no fresh water will be contaminated. Some cover and berm construction material is available on-site, and the remainder within a suitable haul distance. The site is 1.2 kilometres from the airstrip (shortest distance measurement), and 3.6 kilometres from the centre of the community; 2.6 kilometres of roadway must be constructed in order to access the site.

According to sources familiar with Coppermine and its environs, approximately 200 gulls spend the summer at the community. In addition to flying between the community and the waste disposal site, gulls often fly from the disposal site to their nesting area at Locker Point, approximately 60 kilometres northeast of the community. About 200 ravens frequent the waste disposal site, resting primarily in the cliffs adjacent to the community and east of

the airport. These ravens are predisposed to gliding and hovering over the waste disposal site. Unfortunately, the waste disposal site suggested in the consultant's report is situated such that flyways both between the gull-nesting area at Locker Point and the disposal site food source, and between the community and the disposal site food source, intersect aircraft flight paths. (Bird flyways are indicated on Exhibit A-7.)

In addition to the gull and raven population, sandhill cranes and birds of prey, such as peregrine falcons and deer falcons, have been observed. These birds, however, do not represent a significant threat to airport safety. In fact, the falcons help to control the number of birds inhabiting the area. Some geese and a fair number of ducks migrate past Coppermine on their way north to Victoria Island, using the Coppermine River as a migratory guideway. A representative from Coppermine was aware of only one recent bird-strike incident at Coppermine airport: a goose was struck during the summer season, but the aircraft suffered no major damage.

Gjoa Haven

Source Document:

H. J. Bourque, **Design and Operations Concept Report; Gjoa Haven; Solid Waste Disposal**, Stanley Associates Engineering Ltd. (January, 1985).

Situated on the southeast coast of King William Island, Gjoa Haven (Exhibit A-8) is bordered by Peterson Bay to the south and by Rae Strait to the east. To the west, Gjoa Haven Cove penetrates partially inland. A new airstrip built by Transport Canada in 1983 severed access to a disposal site north of the community, and a temporary site southeast of the community (and adjacent to a site used prior to 1975) is presently being used. Since the temporary site is located precisely in the area earmarked for community expansion, a new site must be selected.

1:20,000



- S0 - Previous Waste Disposal Site
- S1 - New Waste Disposal Site
- A - Alstrip
- C - Community

— Bird Flyway

Source: Survey and Mapping Department of
Municipal and Community Affairs, Government
of the Northwest Territories.

Regions northeast of the airport were considered by the consultant to be "too remote" from the community; the cost of constructing access roads would be prohibitive. The remaining site possibilities were confined to the jut of land south of the runway flight path and virtually surrounded by water on the east, south and west. Areas northwest of the community were ruled out due to proximity to the municipal water supply drainage area. Much of the western portion of the feasible site land was visible from the community, thus leaving only three small pockets towards the east of the peninsula in which to locate a waste disposal site.

The proposed site is located in the southernmost of the three pockets, and is separated by 1.6 kilometres from both the airstrip and the community. In order to access the disposal site, the road serving the present disposal site would have to be extended by 1.2 kilometres. The land site is fairly level and somewhat lower than the surrounding lands. Sand, which is readily available in the area, is intended to be used as the landfill cover material.

According to sources familiar with the Gjoa Haven situation, about 300 gulls frequent the waste disposal site, often simultaneously. While community-disposal site flight patterns are fairly well defined, nesting location-disposal site travel is more ambiguous and dispersed and, for this reason, is not indicated on Exhibit A-8. On occasion, gulls have had to be chased off the runway prior to an aircraft landing. Since only an estimated thirty ravens are found at Gjoa Haven, they are not deemed to be hazardous. Other birds observed include sandhill cranes which linger in the small melt water ponds created near runways early in the summer, occasional ptarmigans which have been known to loiter on the runway in search of gravel for food digestion, and Canada geese enroute to Ellesmere Island. The flyway between the community and the proposed waste disposal site is not expected to intersect aircraft flight paths.

Holman

Source Document:

Richard E. K. Feilden, **Planning Study of Water and Sanitation Alternatives; Holman, N.W.T.**, Associated Engineering Alberta Ltd. (March, 1985).

Holman (Exhibit A-9) is located on the south shore of Victoria Island's Diamond Jenness Peninsula. It is bordered by Queen's Bay to the south, King's Bay to the east and Jack's Bay to the northwest. Within 3 kilometres of the community are a number of lakes, including Upkilluk Lake, RCAF Lake, Hidden Lake, Kunak's Lake and Mission Lake, as well as an assortment of unnamed ponds. The present waste disposal site, situated on level ground north of Airport Road and south of Limestone Hill, has been deemed unsatisfactory by the consultant for the following reasons:

- o Lack of natural drainage.
- o Clear visibility from Holman and much of the Airport Road.
- o Tendency for snow drifting, as it is adjacent to high ground.

Although six different site possibilities are explored in the Associated Engineering planning study, all sites east of the Upkilluk River were eliminated due to topography (hilly terrain, rising up to 300 metres), poor drainage, the need to protect the fresh water supply from RCAF Lake, and the community's desire to preserve Upkilluk Lake for recreational purposes and King's Bay for marine fisheries. The only site which was not eliminated was the "Pool Tundra Site". This site integrates with the nearby lagoon sewage disposal site recommended in the same study.

According to the consultant's report, the Pool Tundra Site is far superior to the present waste disposal site with respect to drainage; the land slopes towards Jack's Bay at grades of 1.5% to 2%, steep enough to ensure effective drainage. While the proposed site is visible from Holman and Airport Road, it is not as conspicuous as the existing site. Implementation of the Pool Tundra Site would require construction of a 1.5 kilometre access road, the cost of which would be shared with the sewage service. Gravelly sand for the

1:18,750



— Bird Flyway

- S0 - Existing Waste Disposal Site
- S1 - Proposed Waste Disposal Site
- S2 - Alternate Waste Disposal Site
- A - Alstrip
- C - Community

road base (as well as diking and cover material) is available from a nearby source. The proposed site is 1.5 kilometres from the airstrip and 2.3 kilometres from the community.

Local authorities in Holman observe that roughly 200 gulls appear in Holman during the summer months. The primary gull flyways are between the community and the disposal site, and between the cliffs due east of the community where the gulls prefer to nest and the disposal site. Although gulls do fly to the coast, often in search of freshly caught game at fishing and sealing campsites, no definite coast-disposal site flyways can be distinguished. Again, only a few ravens are present - approximately fifty, at most. These ravens also nest in the cliffs east of the Holman settlement. Small birds, such as snowbuntings, long spurs and grosbeaks can be found individually or in pairs, but keep well away from the community and present virtually no threat to airport safety. In addition, about twenty to fifty geese and hundreds of ducks migrate past Holman on their way to and from the northern islands. The geese, which stop over in Holman for ten days to two weeks in the fall, avoid contact with humans. Neither the community-site flyway nor the cliff-site flyway created by situating the disposal site on the location specified in the consultant's report should conflict with airstrip operations.

An element of indecision surrounds the location of the proposed waste disposal facility at Holman. At a Capital Planning Review meeting in Yellowknife in April 1988, it became known that the Hamlet of Holman was dissatisfied with the location for waste disposal suggested in the consultant's report, and had decided instead to locate the facility north of the airport (marked S2 on the map comprising Exhibit A-9). This relocated site is unfavourably situated with respect to both major flyways defined earlier. Due to the poor positioning of the relocated site in terms of airport safety, the possibility of locating the waste disposal facility somewhere north of the Pool Tundra Site but south of the airport (effectively separating aircraft flight paths from gull/raven flyways) is being considered.

Pelly Bay

Source Documents:

Roland Welker, Pelly Bay, N.W.T.; Evaluation of Alternatives; Final Report; Department of Local Government Water & Sanitation Planning Study, M.M.Dillon Limited. (March, 1986).

Roland Welker, Pelly Bay, N.W.T.; Final Landfill Design and Operations Concept Report, G.C.G.Dillon Consulting Limited. (March, 1986).

As shown in Exhibit A-10, Pelly Bay is situated south of the Kugajuk River at the point where it empties into St. Peter's Bay (a subsidiary of the much larger Pelly Bay). The hamlet lies on the western edge of Simpson Peninsula. The M. M. Dillon study on Pelly Bay (like the Associated Engineering study on Holman) covers water supply and sewage disposal services as well as solid waste disposal services. The report recommends that the existing solid waste disposal site be retained in conjunction with revised methods of operation.

Through the process of elimination, the Dillon study established that the valley used presently for waste disposal is the only feasible site, since:

- o Areas east of the valley drain into recreational bodies of water and potential potable water sources.
- o Areas north of the valley are closer to the community and the airport.
- o Areas north of the community would require the construction of prohibitively expensive bridges and lengthy access roads.
- o Areas west of the valley are closer to the shoreline and would reduce the available buffer.
- o Areas south of the valley are closer to a potable water source (gravel pit) and granular borrow area and are farther from the community.
- o Areas to the extreme south of the valley would require access roads cutting through a 200-metre-high granite ridge.

The solid waste disposal site is adjacent to the current sewage disposal site which, according to the recommendations in the report, should also not be relocated. Because former sites are being used in both cases, new access

1:20,000



- S0 - Existing Waste Disposal Site
- S1 - Proposed Waste Disposal Site
- A - Alstrip
- C - Community

— Blrd- Flyway

Source: Survey and Mapping Department of Municipal and
Community Affairs, Government of the Northwest Territories.

roads need not be constructed, and any access road improvement costs can be covered jointly by sewage and solid waste disposal services. The solid waste disposal site is situated 1.6 kilometres from the airstrip and 1.8 kilometres from the Pelly Bay community.

In Pelly Bay, local authorities have confirmed the presence of about 100 seagulls and an unknown number of ravens. Flyways between the community and the disposal site are predominant. Gulls, however, have been observed flying back and forth to their nesting location about 25 kilometres south of the Pelly Bay coast. While flyways between the nesting location south of the community and the proposed solid waste disposal site steer clear of aircraft flight paths, the route between the community and the disposal site could possibly interfere with airstrip operations.

Spence Bay

Source Document:

R.E.K. Feilden and Norman C. Gridley, **Solid Waste Disposal Study; Spency Bay, N.W.T.**, Associated Engineering Service Ltd. (March, 1981).

Spence Bay (Exhibit A-11) is located on the west coast of Boothia Peninsula. The settlement is situated in a narrow inlet projecting northeastward from the head of Spence Bay. The construction of a new airstrip and terminal building within 360 metres of the present waste disposal site is the primary motive for relocating the site. In addition, residents have complained of the proximity of the present disposal site to the community.

In deciding upon a new waste disposal site, terrain was a limiting factor. Although the terrain is low in relief, it is very rugged, with much of the land surface composed of irregular weathered bedrock hills and outcrops. Road construction among the rock outcrops is costly and difficult, with the result that potential new sites would have to be fairly close to the existing road infrastructure in order to be economically feasible. Sites south of the airport road were deemed to be too close to and too visible by the community,

Spence Bay

1:20,000



- S0 - Existing Waste Disposal Site
- S1 - Proposed Waste Disposal Site
- S2 - Alternate Waste Disposal Site
- S3 - Alternate Waste Disposal Site
- A - Airstrip
- C - Community

— BIRD Flyway

Source: Survey and Mapping Department
of Municipal and Community Affairs,
Government of the Northwest Territories.

while those immediately north of this road were hampered by high rock bluffs and the potential for contaminating water supply and fishing lakes. Ultimately, an area close to a large gravel deposit presently being mined for reconstruction and extension of the airstrip, was selected by the consultant as the most workable future waste disposal site.

The proposed site is advantageous since the gravel deposit provides a ready source of berm and cover material. Only 1.4 kilometres of newly constructed access road is required. However, the site is only 0.6 kilometres from the runway (by shortest distance measurements). Spence Bay, therefore, most severely violates Transport Canada's 8 kilometre separation guideline of the five communities being studied.

About 150 to 175 gulls inhabit Spence Bay during the summer according to sources from that area. Because the current waste disposal site - airport separation is so small (600 metres), gulls flocking to meet the waste collection truck are visible (and their screeching audible) from the airport runway. In addition to flying between the disposal site and the community, Spence Bay gulls have been known to fly to and from nesting locations off the coast about 40 kilometres south of the community. Ravens, too, are present in Spence Bay and frequently fly between the community and the waste disposal site. While flyways between the community and the waste disposal site are roughly parallel to runway alignment (and therefore should not pose serious problems with respect to air traffic), gulls nesting south of Spence Bay could interfere with airport operations enroute to their feeding grounds at the proposed disposal site.

In the study by Chinniah referred to previously, one objective was to determine alternative locations for waste disposal, expressly for the reason that the proposed landfill site would be far too close to the airport. Two sites were deemed feasible for further consideration, one west of the airport (marked S2 on Exhibit A-11) and one southeast of the community-across a narrow portion of Spence Bay (marked S3 on Exhibit A-11). Although the southeastern site fared better than the western site in an economic analysis, the report recommended that the western site be selected since the community

would be subject to adverse environmental effects (noise, odour, smoke, dust, etc.) if the southeastern site were implemented. Both sites are approximately 2.5 kilometres from the airport. While the southeastern site poses no problem with respect to conflicts between bird flyways and aircraft flight paths, the western site advocated by the study is contentious in terms of the community disposal site flyway.

4. Summary Comparison

In certain respects, these five airports are relatively safe from the standpoint of potential bird strikes. Bird populations are small and migratory flyways are of minor relevance. The lands surrounding all the air strips have weathered, rocky terrain and limited vegetative cover. As such, they are all environmentally similar to the airport lands; birds then would not be attracted specifically to the airports for the purposes of feeding on grass, worms or insects which live in grass, or resting in an open area with good visibility. Air traffic is light: even Coppermine averages less than five take-offs or landings per day. Furthermore, in Gjoa Haven, Pelly Bay and Spence Bay, piston-engined aircraft constitute the majority of traffic.

As summarized in Exhibit A-12, all proposed disposal sites are within 1.6 kilometres of the airstrips, well short of the Transport Canada guideline. In addition, flyways between the site and the community and between the site and gull cliff/coast nesting locations intersecting with aircraft flight paths, could present problems in three of the five cases (Coppermine, Pelly Bay and Spence Bay).

Gjoa Haven's and Holman's waste disposal sites appear to be favourably located with respect to potential bird problems. Given the low bird populations and low air traffic volumes, separations between disposal sites and airports are probably adequate. Holman, however, is characterized by relatively heavy use of turbo-propeller aircraft (63% of 1986- itinerant aircraft movements.)

Exhibit A-12

Comparison of Solid Waste Disposal Sites

	Coppermine	Gjoa Haven	Holman	Pelly Bay	Spence Bay
Shortest distance from site to airstrip (km)	1.2	1.6	1.5	1.6	0.6
Distance from site to center of community (km)	3.6	1.6	2.3	1.8	2.0
Potential conflicts with aircraft flight paths:					
Coast-Site Flyway	Yes	No	No	No	Yes
Community-Site Flyway	Yes	No	No	Yes	No
1986 Aircraft movements	1680	823	694	897	699
% Turbo-propeller aircraft in 1986	68%	22%	63%	42%	36%
New road requirements (km)	2.6	1.2	1.5	0	1.4

In the case of Coppermine, both coast-disposal site and community-disposal site flyways may interfere with airport operations. Even though Coppermine is hardly comparable in terms of annual aircraft movements to a major centre like Yellowknife, it does receive sufficient traffic to warrant a flight service station. Presently, Coppermine has roughly twice as much air traffic as the other four communities studied. In addition, about 65% of itinerant aircraft movements involve turbo-propeller aircraft, and this percentage is expected to increase in the future. Given these air traffic conditions and the possibly conflicting paths of birds and aircraft, location of the waste disposal site for Coppermine probably requires more detailed consideration, including the possibility of using various mitigating measures.

Pelly Bay's proposed waste disposal site may also be problematic. At Pelly Bay, only the community-site flyway would potentially interfere with airport operations; the coast-site flyway seems to present no difficulty. Of the two types of flyways, however, the former (community-site) is more critical, since it is used by both ravens and gulls and because it is a more established flight pattern. The growth rate in annual aircraft movements has been rapid and consistent in Pelly Bay and, since all provisioning must be done by airlift, annual aircraft movements are not likely to decrease unless population declines.

Finally, in the case of Spence Bay, while only the coast-site flyway intersects with aircraft flight paths, the site is at such close proximity to the runway (600 metres) that the limited number of birds hovering around the site may conflict with aircraft movements. In addition, the Spence Bay airport serves as a "hub" from which connecting flights or "spokes" to Kitikmeot and Baffin communities are based. As air traffic to these "spoke" communities increases, traffic at Spence Bay will also increase.

